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Towards a model of Mathematics attitudes formation

Through the child's perception of social agents and self-beliefs

Elaboration d'un modèle de la formation des attitudes en mathématiques : influence des croyances des élèves et de leur perception de leurs parents et de leurs enseignants

Sous la direction de Mme Michèle KIRCH, Professeure

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Dedicated to

my Mother's smile that she used to give me despite of all pains of the life

And to my Father's eyes who always wish to see me like a sun in the sky...

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Introduction

Dans le domaine de l’éducation aux mathématiques, les recherches sur les performances scolaires et les attitudes reflètent, en général, que l’apprentissage des mathématiques dépend en partie des perceptions des élèves, et est relié à leur attitude et à leurs performances. Les recherches en particulier dans le domaine des sciences cognitives et sociales, démontrent que ces perceptions des élèves dérivent des significations que les choses ont pour eux. En ce qui concerne l’attitude, les significations données aux objets et les relations entre eux lorsqu’elles sont construites à travers l’interaction sociale et les expériences qu’une personne rencontre, développent des attitudes spécifiques envers ces objets. Ces attitudes peuvent de plus guider les actions des êtres humains (Blumer, 1969, p.2).

La métaphore “attitude” passe par des étapes variées, de manière évolutive. Elle est parfois considérée comme l’état mental de préparation (Allport, 1968), comme une prédisposition pour répondre à une classe spécifique d’objets (Rosenberg & Hovland, 1960), comme une prédisposition pour l’apprentissage (Fishbein & Ajzen, 1975) et parfois comme un état d’évaluation (Oskam & Schitz, 2005).

A propos de l'enseignement des mathématiques, la recherche sur l'attitude envers les mathématiques a une place non négligeable. On a toujours cru qu’une attitude positive envers les mathématiques est cruciale pour l'apprentissage de cette discipline (Neale, 1969). Cette croyance a orienté la recherche sur l'attitude envers les mathématiques selon deux axes : l'un vers la mesure des attitudes en mathématiques et en explorant leur relation de causalité avec la réussite. Le deuxième axe consiste en l'élaboration d'un cadre théorique de ce concept dans le cadre de l'enseignement des mathématiques. La revue de littérature montre que la plupart des travaux se focalise sur la mesure des attitudes envers les mathématiques et que le cadre théorique, pour des raisons épistémologiques, n’a pas été l’objet de suffisamment d'attention (Di Martino & Zan, 2001). Les chercheurs en éducation ont emprunté cette conception à la psychologie sociale ou cognitive tout en élaborant le concept d'attitude envers les mathématiques. Il est largement admis que l'évaluation des mathématiques par un individu, basée sur des composantes cognitives ou affectives ou parfois sur les deux, est considéré comme l'attitude envers les mathématiques (Aiken, 1970; Papanastasiou, 2000; Zan & Di Martino, 2007). Et parfois, la «croyance» a été prise comme partie intégrante de la mesure de l'attitude envers les mathématiques, sur la base des intérêts ou des sentiments pour cette discipline (Pehkonen, 2003; Torner, 2002). Alors que d’autres chercheurs donnent un seul chiffre pour la mesure de l’attitude, et considèrent en outre les composantes de l’attitude comme unidimensionnelles (Fennema & Sherman, 1976; Ma & Kishor, 1997; Lafortune, 1998). Cependant, l'attitude envers les mathématiques représentée globalement par un seul chiffre qui décrirait une attitude positive ou négative, peut cacher une inclination particulière. Cette inclination particulière, si elle était révélée pourrait montrer des aspects spécifiques des composantes cognitives ou affectives. Par conséquent, il est nécessaire d’avoir un cadre théorique de l'attitude envers les mathématiques qui contienne les différentes formes ou dimensions des composantes, afin d'révéler les aspects cachés de l'attitude.

Ainsi, cette étude vise à proposer un cadre théorique de l'attitude envers les mathématiques qui offre une vue multidimensionnelle des composantes cognitives et affectives à un niveau plus fin d’analyse que les concepts antérieurs. Voici les quatre objectifs principaux de cette recherche.

La cadre théorique du concept d'attitude envers les mathématiques : le premier objectif de cette recherche

De la même façon que les significations ou la connaissance personnelle construites à partir de l'interaction entre les facteurs interpersonnels et socio-psychologiques, les réactions affectives antérieures envers les mathématiques constituent des sentiments, positifs ou négatifs. Par ailleurs, la mémoire de l'élève de sa croyance antérieure à propos des mathématiques et de sa propre compétence dans cette discipline, véhiculées par des facteurs sociaux et des réactions affectives, sont des facteurs déterminants de l'attitude envers les mathématiques. Nous proposons dans cette étude une conception théorique sur les attitudes envers les mathématiques. Nous avons supposé que l'attitude envers les mathématiques est basée sur deux composantes : l'intérêt pour les mathématiques, et les croyances liées aux mathématiques, sur les bases desquels un élève peut donner un jugement d'évaluation au sujet des mathématiques et de ses possible apprentissages dans cette discipline. Nous proposons donc la définition de l'attitude envers les mathématiques suivante : *une évaluation positive ou négative des mathématiques sur les bases de ses propres intérêt et croyance*.

Afin d'explorer plus avant cet état évaluatif, nous avons proposons dans cette étude un concept multidimensionnel des composantes de l'attitude envers les mathématiques. L'intérêt en mathématiques, une composante affective, a été délimité en trois dimensions. Une dimension concerne l'état psychologique de l'intérêt lié à la situation qu'un élève rencontre lorsqu'il fait des mathématiques. La deuxième dimension de l'intérêt est basée sur des sentiments concernant ses expériences précédentes dans cette discipline. La troisième dimension de l'intérêt en mathématiques traite conceptuellement de l'amour de cette discipline basé sur son poids dans la réussite scolaire. La croyance à propos des mathématiques est également analysée en trois dimensions : une dimension est basée sur la croyance en l'utilité globale des mathématiques ; une autre dimension représente la croyance que les mathématiques favorisent la pensée critique et ont une utilité dans la vie quotidienne. La troisième dimension de la croyance en mathématiques concerne la satisfaction personnelle dans le domaine financière par exemple, ou de l'estime de soi.

Le modèle théorique de la formation de l'attitude envers les mathématiques : *le deuxième objectif de notre étude*

Pendant les quatre dernières décennies, la recherche en didactique des mathématiques basée sur l'hypothèse que « les capacités pour faire des mathématiques sont très influencées pas les attitudes des élèves » a été faite dans le cadre d'une approche socio-psychologique, pour aborder la question du genre (Fennema, 1981; Jones, et al., 2000; Blondin & Lafontaine, 2005). L'objectif majeur de cette approche était de découvrir la relation entre les performances en mathématiques et les attitudes envers cette discipline, et si l'on voit des différences entre les garçons et les filles à propos de cette relation.

Les recherches indiquent également que l'intérêt et la valeur attribuée aux mathématiques sont les principaux ingrédients dans le processus de formation des attitudes des élèves envers cette discipline ; et que ce sont bien les attitudes qui prédisent la participation des élèves et leur réussite dans ce sujet d'étude (Zan *et al*. 2006). Mais comment les attitudes en mathématiques se développent-elles parmi les garçons et filles sous l'influence de la diversité de certaines conditions sociales ? Pourquoi y-a-t-il des différences dans l'intensité de leurs attitudes ? Ces questions doivent être explorées spécifiquement à la lumière de la diversité sociale et culturelle.

Par conséquent, cette étude s'intéresse à ce phénomène complexe de la formation des attitudes envers les mathématiques sous l'influence des facteurs sociaux qui fournissent à l'enfant l'environnement à l'intérieur duquel il va développer ses perceptions sur soi-même et sur les autres.

Après avoir réalisé une revue de la littérature, notre recherche étudiera les facteurs incontournables qui favorisent la formation des attitudes des élèves envers l'apprentissage des mathématiques. Nous proposons un modèle théorique de formation des attitudes des élèves envers les mathématiques. Dans ce modèle, nous faisons l'hypothèse que les tendances évaluatives de l'élève, les sentiments et perceptions des les mathématiques ainsi que les croyances sur ses compétences dans cette discipline se développent sous l'influence des agents sociaux (parents et enseignants).

Les facteurs sociaux influencés par des normes culturelles, des valeurs sociales et des croyances sur les stéréotypes confèrent à un enfant un rôle particulier en fonction en plus ses caractéristiques propres : le genre, le statut socio-économique et les capacités. Ces caractéristiques définissent le mode et l'intensité de ses expériences.

Ces expériences, qui peuvent avoir des résultats différents en fonction du genre de l'enfant, conduisent à la construction de connaissances et de croyances sur la perception de soi. Les attentes et les valeurs, transmises par les facteurs sociaux (parents et enseignants), influencent directement l'élève dans le processus de développement du concept de soi et de l'auto-efficacité.

L'élève utilise ces croyances sur soi, passées au filtre des stéréotypes sociétaux, afin d'interpréter ses croyances sur ses compétences en mathématiques sur la base de ses expériences passées en mathématiques. Il développe en conséquence son aspiration pour la réussite. L'élément le plus important dans cette construction de la croyance sur ses possibilités en mathématiques est la perception de l'élève des attentes de ses pairs, ainsi que les encouragements et les attitudes de ses parents et de ses enseignants envers lui. Comment un enfant perçoit-il les croyances de ses parents à son égard à travers le prisme du genre ? Et à l'école, en tant qu'un élève, qu'est ce qu'il perçoit de l'attitude de l'enseignant ? La manière dont l'élève perçoit le comportement de l'enseignant et de ses parents envers lui est un élément plus important dans le développement du concept de soi et de l'auto-efficacité en mathématiques que la façon dont parents et enseignants le perçoivent.

Ces propres croyances en mathématiques, additionnées aux effets de la réussite, et à l'importance dans la vie réelle des mathématiques communiquée par l'enseignant se transforment en intérêt envers les mathématiques. De plus, l'utilité et les croyances communiquées par les parents, sur la valeur des mathématiques pour aspirer à une carrière future contribuent au développement de la croyance en mathématiques chez l'élève. Ce jugement évaluatif, oriente l'attitude de l'élève envers l'apprentissage des mathématiques.

Par ailleurs, le deuxième objectif principal de notre recherche a été de théoriser la relation causale entre les variables liées à la perception de l'élève sur les facteurs sociaux (parents et enseignants en maths) et les variables « croyances de soi » dans la formation de son attitude envers les mathématiques et l'apprentissage de cette discipline.

Développement des échelles de recherche : le troisième objectif de cette étude

L'attitude d'un individu envers les mathématiques dépend de l'intensité des relations qu'il a avec cette discipline sous l'influence des préférences personnelles et des facteurs sociaux. De plus, en raison des différences que nous avons établies au niveau des préférences liés aux exigences sociales et culturelles, une échelle de mesure d'attitude développée pour les élèves appartenant à une société en particulier, ne peut être effectivement applicable aux élèves d'autres sociétés qui ne partagent pas les mêmes normes et valeurs culturelles.

De plus, la revue de littérature révèle que de nombreuses échelles de mesure concernant l'attitude envers les mathématiques ont été développées et appliquées dans les pays occidentaux. Les infrastructures et valeurs culturelles de chaque société sont assez différentes de celles d'un pays en développement comme le Pakistan.

Ainsi, les facteurs influençant l'attitude envers les mathématiques des élèves des pays de l'ouest qui ont étudié dans des systèmes d'éducation différents ne sont pas les mêmes que pour les élèves pakistanais. De ce fait, les modifications des échelles qui ont été déjà développées pourraient soulever des questions de fiabilité concernant les langues et le contenu. Cette situation est d'autant plus sensible si l'on s'intéresse à mesurer l'influence des facteurs sociaux dans la formation des attitudes envers les mathématiques. C'est pourquoi le prochain objectif principal de cette étude visait la conception d'une échelle de mesure appropriée pour les élèves pakistanais afin de mesurer leur attitude envers les mathématiques en construisant un dimensionnement propre. Afin de tester et de valider notre modèle théorique, d'autres échelles ont été nécessaires pour mesurer l'influence des variables « parents » et « enseignants » et les croyances personnelle des élèves sur leurs capacités en mathématiques.

Vérification et validation du modèle hypothétique de la formation des attitudes en mathématiques : quatrième objectif de notre recherche

Le dernier objectif principal de cette recherche a été de vérifier l'existence pratique du modèle théorique proposé en utilisant les données statistiques. Pour atteindre cet objectif il était nécessaire de proposer un modèle hypothétique prenant en compte toutes les pistes causales entre les variables endogènes et exogènes. Sur la base du modèle théorique propose, nous avons donc développé un modèle hypothétique de formation d'attitude envers les mathématiques basé sur toutes les variables exogènes, les médiateurs et les variables endogènes.

Afin de valider le modèle théorique sous plusieurs formes, nous avons élaboré différents types de modèles hypothétiques :

Modèles hypothétique de niveau 1 (parents, enseignant et élève), de niveau 2 (sous-variables « parents », « enseignant » et sous variables « élève »), et de niveau 3 (uniquement sous-variables « enseignant » et sous-variables « élève »).

Modèle hypothétiques de degré 1 (basé sur deux composantes, intérêt et croyance) et de degré 2 (basé sur les 6 dimensions des composantes).

Les trois modèles finalement utilisés ont été les modèles de niveau 1 et de degré 1, de niveau 2 et de degré 1, de niveau 3 et de degré 2.

Pour le modèle de niveau 1 et de degré 1, que les variables concernant la perception des parents et les variables « enseignant » sont reliées indirectement par les croyances en soi en mathématiques des élèves ou directement, ces variables causent alors un effet sur le développement de l'intérêt et de la croyance en les mathématiques pour former l'attitude envers l'apprentissage de cette discipline.

Le modèle hypothétique suivant « niveau deux et degré un » a consisté à prendre en compte onze variables. Parmi celles-ci, les variables exogènes ont été décomposées en six variables : le soutien des parents, les attentes des parents, les croyances stéréotypiques, la pédagogie de l'enseignant, son encouragement et son comportement.

La variable « médiateur » de croyance en soi de l'élève en mathématiques a été divisée en trois variables : le concept de soi en mathématiques, l'auto-efficacité en mathématiques et la croyance stéréotypique en cette même discipline. Par la suite, à ce niveau, la variable « genre » a été introduit dans ce modèle pour explorer comment les garçons et les filles sont différents dans la formation des attitudes.

Afin d'étudier les relations de causalité entre les variables exogènes et endogènes au niveau micro, nous avons introduit notre modèle hypothétique de niveau trois et de degré deux. Dans ce modèle, nous avons employé douze variables : trois variables d'enseignants, trois variables « médiateurs » et six variables concernant les six dimensions de l'attitude en mathématiques. A cette étape, un autre objectif secondaire était d'explorer les pistes causales d'influence entre les six dimensions de l'attitude envers les mathématiques.

Les questions de recherche, qui font l'objet de la section suivante, ont été posées en s'appuyant sur ces objectifs principaux et d'autres objectifs secondaires de notre étude.

Les questions de recherche :

A la lumière de la revue de littérature et des objectifs de nos travaux, notre recherche actuelle contribue à l'étude du processus qui influence la perception d'un élève en vue de développer l'attitude envers l'apprentissage des mathématiques.

Par conséquent, l'enquête de cette recherche a été construite selon deux axes: le premier axe portait sur les différences entre les élèves concernant l'attitude envers les mathématiques sur la base du genre, de l'âge et du statut socio-économique. Le deuxième axe a été ciblé pour explorer les relations d'ordre séquentiel des variables exogènes et endogènes dans la formation de l'attitude envers l'apprentissage des mathématiques.

Dans le cadre de différences entre les élèves, les recherches (Hyde et al 1990, TIMSS, 1999; Li, 2004; Blondin & Lafontaine, 2005) ont examiné les différences de genre dans l'attitude envers les mathématiques et ont surtout souligné l'attitude significativement plus positive envers les mathématiques des garçons. Cette recherche a tenté d'explorer cette question dans les composantes (intérêt et croyance) et la forme des dimensions. Par conséquent, la première recherche a été :

- les filles et les garçons diffèrent-ils dans l'attitude envers les mathématiques?

si oui, alors, cette situation existe-t-elles dans les deux composantes? Ou, restrictivement :

- y a t-il certaines dimensions où cette différence persiste?

Des études ont également indiqué que les élèves dans les classes supérieures ont démontré une attitude moins positive envers les mathématiques que les élèves des classes primaires (Ma & Kishor, 1997; TIMSS, 1999). Par conséquent, ici se pose la question:

- l'âge est-il un agent modérateur dans la formation de l'attitude des élèves envers l'apprentissage des mathématiques?

si oui, alors:

- est-ce que l'âge et le sexe interagissent de manière significative? Les filles et les garçons montrent-ils une variation semblable dans leurs attitudes envers les mathématiques aux différents âges?

Et enfin, dans le cadre du statut socio-économique :

- est-ce que le statut socio-économique des parents (en termes de leur niveau d'éducation et de la nature de leur profession) joue un rôle important dans le développement de l'attitude positive envers les mathématiques en termes de croyance concernant le besoin?

si oui, alors, à quel âge cet effet est-il le plus important?

Le deuxième axe de cette étude a été basé sur le test et la validation du modèle structurel de la formation de l'attitude envers les mathématiques qui traite de la question majeur suivante :

- Les relations causales entre les perceptions de l'élève sur les variables sociales (parents et enseignants de mathématiques) et la confiance en soi concernant les mathématiques sont-elle significatives dans la formation de son attitude envers l'apprentissage des mathématiques?

Pour répondre à ces questions de recherche, la méthodologie de recherche décrite à la suite a été adoptée.

La méthodologie de la recherche :

Cette recherche est structurée en deux niveaux principaux : le premier traite du développement des échelles appropriées pour mesurer les attitudes des élèves envers les mathématiques, leur perception quant à l'influence d'autres agents sociaux et leur propre croyance. Le second niveau concerne l'administration de l'instrument sur l'échantillon final l'analyse et l'interprétation des résultats.

Par conséquent, nous avons utilisé une méthodologie mixte de recherche, semi-qualitative et quantitative. Au total, trois enquêtes ont été administrées. Nous avons adopté la méthodologie de l'enquête semi-qualitative pour l'enquête préliminaire et la méthodologie de l'enquête quantitative a été utilisée pour le test pilote et pour l'enquête finale.

Échantillonnage:

Cette étude visait à explorer la relation de causalité entre les facteurs sociaux et les facteurs interpersonnels dans le développement d'attitudes envers les mathématiques des élèves des écoles pakistanaises. Par conséquent, afin de développer un instrument de recherche qui tienne compte des facteurs, styles et langages qui relèvent de la société pakistanaise, nous avons eu besoin de collecter des informations pertinentes. Les étudiants de l'université du Pakistan qui préparaient leur diplôme avec les mathématiques comme majeure ont été la population idéale pour l'enquête préliminaire, pour avoir de l'information au sujet de leurs sentiments, les incitations et la motivation envers cette discipline.

Cette étude a été limitée à la province du Pendjab ; par conséquent, par un échantillonnage raisonné, trois universités et établissements d'études supérieures ont été choisis pour mener cette enquête préliminaire. Environ 94 étudiants suivant des cours de mathématique en licence (55 femmes, 19 hommes) et master (10 femmes, 10 hommes), ont participé à cette enquête.

Cette recherche a été délimitée pour les élèves de deux groupes d'âge : 10-11 ans et 13-14 ans. Une autre limitation de l'enquête en cours a été de choisir les villes où les facilités éducatives sont relativement meilleures (la disponibilité des écoles secondaires à la fois pour les filles et les garçons, les chances pour les filles de faire des études supérieures, etc.) et où le taux d'alphabétisation était de plus de 50 %.

Par ailleurs, afin de maximiser la normalisation des instruments de recherche, la diversité dans la culture et le statut socio-économique ont aussi été considérés. En gardant toutes ces conditions à l'esprit, une enquête pilote a été conduite dans les quatre écoles urbaines de trois villes pakistanaises : Islamabad, Lahore et Sargodha. A cette expérimentation ont participé 234 élèves (121 filles et 113 garçons) provenant de quatre écoles publiques, leurs tranches d'âge étaient de 10-11 ans, et de 13-14 ans.

L'étape suivante de la collecte finale des données, dix écoles au total (5 écoles publiques et 5 écoles privées) des deux villes de Lahore et de Sargodha ont été sélectionnées par des échantillonnages guidé par l'accessibilité. Au total 1499 élèves (678 filles et 821 garçons) provenant de la sixième et de la neuvième classe ont participé à l'enquête finale. Sur l'échantillon total, 751 élèves (397 filles et 354 garçons) étaient en sixième alors que 748 élèves (281 filles et 467 garçons) étaient en neuvième.

Développement de l'instrument de recherche

Nous avons développé un questionnaire basé sur deux questions ouvertes et une liste de facteurs importants qui peuvent influencer l'attitude afin de mener l'enquête préliminaire. Les données qualitatives de cette enquête ont été analysées par l'analyse textuelle et une base de 89 items a été créée répartis en quatre échelles. Ces échelles ont visé à mesurer la perception des élèves de l'influence de leurs parents, de l'effet de l'enseignant, de leurs croyances personnelles sur les mathématiques, et de leur attitude envers les mathématiques. Ces échelles initiales basées sur 5 points de l'échelle de Likert ont été ensuite affinées à travers le processus de validation de contenu ; nous avons obtenu finalement 77 items valides.

A l'étape suivante, afin d'extraire les facteurs et de mesurer la fiabilité de ces échelles, une analyse factorielle exploratoire (*Exploratory Factor Analysis*) a été utilisée sur les données avec une rotation orthogonale VARIMAX avec normalisation de Kaiser pour trier les facteurs mesurant certaines caractéristiques. Lors de cette étape, un *factor loading* supérieur à 0,4 a été sélectionné. Puis 14 facteurs ont été extraits à partir de ces échelles ; six facteurs issus de l'échelle mesurant les attitudes envers les mathématiques, trois facteurs issus de l'échelle des parents, trois facteurs issus de l'échelle des enseignants et deux facteurs issus de l'échelle sur les croyances personnelles. Une échelle « les garçons sont meilleurs en mathématiques » basée sur trois items a été ajoutée. De plus, le coefficient Alpha de Cronbach a été calculé pour mesurer la cohérence interne de chaque échelle.

Finalement, ces quatre échelles et l'échelle additionnelle « les garçons sont meilleurs en maths » (57 items au total), ont été administrées auprès des élèves ayant une moyenne d'âge de 11,30 ans et de 14,34 ans pour l'enquête finale.

Les données collectées ont été traitées et analysées en utilisant les logiciels SPSS et AMOS v.18 (Arbuckle, 2005). Dans la démarche d'analyse des données à la lumière de nos questions de recherche et de nos hypothèses, nous avons utilisé les statistiques descriptives et inférentielles, les analyses multivariées (ANOVA et MANOVA), ainsi que la modélisation par équation structurelle (Tabachnick & Fidell, 2007; Hair et al, 2010; Kline, 2011).

Les résultats :

Les données recueillies à partir de l'enquête finale ont été traitées en utilisant des statistiques descriptives sur tous les facteurs de notre modèle. Les résultats obtenus montrent globalement une attitude positive des élèves envers les mathématiques. Comme notre étude a été conduite en prenant en compte les deux groupes filles et garçons selon deux groupes d'âge, le genre et l'âge ont été nos variables modératrices majeures.

Par conséquent, avant de procéder à une analyse multivariée sur les données afin de rechercher la réponse aux questions de recherche, il a été nécessaire de vérifier l'hypothèse d'homogénéité des variances. Afin de vérifier l'homogénéité des variances particulièrement pour notre échelle de mesure des attitudes envers les mathématiques concernant le genre, nous avons calculé le test d'homogénéité de Levene sur la base des résultats obtenus. Les résultats ont montré que l'hypothèse des variances homogènes est satisfaite pour la variable de genre dans les attitudes envers les mathématiques [F (1, 1278) = 3.848] et de même pour les deux composantes de l'attitude : la croyance en mathématiques [F (1, 1393) = .001] et l'intérêt en mathématiques [F (1, 1350) = 6.398] à p > .01.

Par contre, pour la variable "âge", le test d'homogénéité n'est pas satisfait par le test de Levene. Par conséquent, les tests de Welch et Brown-Forsythe d'homogénéité ont été adoptés pour lesquels l'homogénéité des données a été satisfaite pour la variable « âge ».

Après avoir traité l'hypothèse de base sur l'homogénéité, nous avons appliqué des analyses multivariées à la lumière de nos questions de recherche ; les résultats sont donnés ci-dessous.

Les résultats des analyses multivariées

Afin de vérifier si le genre est une variable significative pour l'attitude envers les mathématiques, nous avons appliqué ANOVA sur les données recueillies.

Les résultats ont démontré qu'il n'y avait aucune différence de genre dans l'attitude envers les mathématiques lorsqu'il a été considéré comme seul index, pas plus que dans ses composantes. Cependant, lorsque des données ont été analysées séparément pour les six dimensions de l'attitude, nous avons trouvé des différences de genre pour deux d'entre elles.

Les filles ont démontré une attitude significativement plus positive que les garçons en ce qui concerne la « croyance de besoin » [F (1, 1471) = 9.507, p <0.001]. Alors que les garçons ont montré une attitude significativement plus positive que les filles en termes de « plaisir» [F (1, 1469) = 4.503, p <.05].

Concernant l'effet de l'âge, les résultats ont montré que des élèves de classe de neuvième ont une attitude significativement plus positive envers l'apprentissage des mathématiques [F (1, 1278) = 4.996, p <0.05] ainsi que pour ce qui est de la composante «intérêt en mathématique» [F (1, 1350) = 14.714, p <0.001] que les élèves de classe de sixième.

Cependant, en ce qui concerne la « croyance en mathématiques », nous n'avons pas trouvé de différence significative entre les deux groupes d'âge. Les données ont ensuite été analysées pour les six dimensions de l'attitude envers les mathématiques.

La variable « croyance en mathématiques» n'est pas apparue significativement différente pour les élèves des deux groupes d'âge. En ce qui concerne la sous-variable « croyance sur le développement intellectuel » les résultats nous amènent à constater que les élèves de neuvième année ont montré une croyance plus positive que les élèves de sixième année [F (1, 1441) = 5.882, p <.05].

A l'étape suivante, en ce qui concerne notre troisième principale question celle de la variation de l'attitude envers l'apprentissage des mathématiques à travers les années pour les garçons et les filles, nous avons utilisé la technique MANOVA. Les résultats montrent que l'interaction entre l'âge et le genre est significative pour la variable « intérêt en mathématiques » : l'intérêt envers les mathématiques augmente avec l'âge chez les filles et les garçons, un peu plus chez les filles.

Cette composante (l'intérêt) a été étudiée ensuite en fonction de ses dimensions. L'interaction entre le genre et l'âge a été trouvée significative seulement dans sa dimension représentée par la variable « plaisir ». L'écart entre garçons et filles pour apprécier le plaisir de faire des mathématiques a été réduit au fur et à mesure qu'ils ont avancé dans la classe supérieure [F (3, 1348) = 12,79, p <0.001].

Ce résultat a montré que l'effet de l'âge dans le développement de l'intérêt des mathématiques était différent pour les garçons qu'il ne l'était pour les filles. Bien que les filles ont montré un intérêt relativement plus faible en mathématiques que les garçons dans les deux groupes d'âge, la différence entre les genres a été considérablement réduite avec l'âge.

Nous n'avons par contre pas trouvé d'interaction significative entre le genre et l'âge pour la variable « croyance en mathématiques ». Cette interaction était cependant significative pour ses dimensions « croyance du développement intellectuel » [F (3, 1391) = 7.229, p <0.001] et « croyance-besoin » [F (3, 1391) = 7.409, p <0.001].

Les résultats ont indiqué qu'en avançant dans les classes supérieures, l'âge affecte la croyance des élèves en ce qui concerne les mathématiques pour le « développement intellectuel » de façon différente pour les garçons et les filles. Avec l'âge, les garçons se sont améliorés dans cette croyance, contrairement aux filles pour lesquels cette croyance décline.

Pour la dimension « croyance-besoin », l'âge joue un rôle important dans la modification de cette croyance. Arrivés en classe supérieure, les élèves (garçons et filles) ont exprimé la conviction que les mathématiques sont une source de satisfaction pour les besoins financiers et la « reconnaissance de soi ».

Enfin, concernant la quatrième principale question celle de l'effet du statut socio-économique des parents sur le développement de la « croyance-besoin », ANOVA univarié a été appliquée sur les données. Quatre groupes d'élèves selon le niveau d'éducation du père ont été trouvés significativement différents [F (3, 1443) = 5.425, p <0.01].

Par l'utilisation le test de Boneferoni post hoc, nous avons découvert que les élèves des deux groupes, « pères illettrés » et « pères intellectuels », montrent une différence significative sur les croyances en lien avec les mathématiques. Ainsi, les élèves appartenant au groupe dont « le père n'est pas éduqué » montrent des croyances plus significativement positives liées aux mathématiques (comme un moyen d'obtenir une bourse d'étude, un bon travail et l'auto-reconnaissance) que ceux dont « le père a un niveau élevé d'études ». Par ailleurs, les résultats ont montré qu'il y avait plus de filles que de garçons qui adhérent à cette croyance.

De même, la variable « éducation de la mère » est également apparue comme une variable importante pour le développement de cette même dimension de l'attitude envers les mathématiques [F (3, 1447) = 4.757, p <0.01]. Les élèves dont les mères n'ont « aucune éducation / ou jusqu'au primaire » ont montré une croyance plus significativement positive liées au «besoin» des mathématiques que ceux dont les mères ont un haut niveau d'éducation. Enfin, en ce qui concerne la profession du père, nous n'avons trouvé aucune différence significative entre les élèves.

Ces résultats ont démontré que le bas niveau d'éducation des parents est une raison d'augmentation de la « croyance-besoin » en les mathématiques.

Résultats des modèles des équations structurelles : l'analyse des pistes causales

Dans l'étape suivante, vers le validation de notre modèle hypothétique général à "niveau un et degré un" (effet collectif de tous les facteurs sur chaque variable), nous avons calculé les corrélations entre les variables. Avec toutes les pistes possibles de causalité, le modèle a été exécuté dans le logiciel AMOS et ajusté par la méthode du maximum de vraisemblance. Plusieurs modèles ont été testés, on a trouvé celui qui avait le meilleur ajustement des données, avec les statistiques χ^2 =1.695 (df =1), χ^2 normalisé = 1.695, NFI = 0.999, CFI = 0.999, RMSEA = 0.022.

Tous les indices (absolue, de normé, et de parcimonie) ont indiqué que le modèle théorique proposé dans cette étude existe, donc la deuxième question principale de notre recherche a été satisfaite. Les pistes significatives de causalité ont confirmé l'hypothèse que les parents influencent directement le développement de la croyance en mathématiques chez les élèves (effet total = 0,11). Alors que pour l'intérêt en mathématiques, un effet indirect a été établi, médié par la variable « croyance en soi » des élèves (effet total = 0,08).

De plus, on a montré que l'autre variable exogène, l' « enseignant », est une variable à forte influence. Nous avons trouvé que la perception qu'a l'élève de l'enseignant développe un effet causal, directement et indirectement dans les deux sens, sur la croyance en mathématiques (effet total = 0,324) et l'intérêt en mathématiques (effet total = 0,457). Par ailleurs, nous avons observé que dans la construction de l'attitude des élèves envers les mathématiques, le lien de causalité allant de l'intérêt en mathématiques vers la croyance est plus significatif (b = 0,3). Ainsi, cette étude a montré que la croyance en mathématiques est subit l'influence indirecte des variables exogènes et l'influence directe de l'intérêt en mathématiques.

Dans l'étape suivante, en lien avec la validation du modèle « niveau deux et degré un » (avec six variables exogènes, trois variables médiatrices et les deux variables endogènes de l'attitude envers les mathématiques), nous avons calculé les corrélations entre les onze variables et les pistes causales possibles ont été tracées à la lumière des corrélation significatives. Nous avons testé plus de cinquante modèles avec différentes combinaisons des pistes causales à la lumière de la théorie. Un modèle présente des statistiques relativement meilleures que les autres avec χ^2 =386.315 (df = 63), NFI = 0.907, CFI = 0.919, RMSEA = 0.05. Dans l'absolu, les indices statistiques indiquent que le modele « niveau deux et degree un » est aussi validé.

Les pistes de causalité ont démontré que le soutien des parents et leurs attentes cause un effet direct sur l'auto-efficacité et le concept de soi, ce qui provoque indirectment un effet sur le développement de l'attitude envers les mathématiques. Tandis qu'un coefficient de régression fortement positif entre la croyance stéréotypée des parents et la croyance stéréotypée de l'élève montre que de tels stéréotypes de genre concernant les compétences en mathématiques sont principalement produits par les parents dans l'environnement familial.

Par ailleurs, un fort effet de la variable « enseignant » a été trouvé sur le développement de la croyance et de l'intérêt en mathématiques. Nous avons trouvé que la perception de l'élève de la pédagogie de l'enseignant, ses encouragements et son comportement ont un effet causal direct sur le concept de soi en mathématiques et un effet indirect sur l'auto-efficacité en mathématiques. Parmi ces trois variables exogènes, la pédagogie de l'enseignant provoque une relation causale directe et indirecte (médiée par le concept de soi) avec le développement de la croyance en mathématiques. Alors que les encouragements de l'enseignant influencer l'intérêt en mathématiques à la fois directement et indirectement. Le coefficient de régression négatif entre le comportement de l'enseignant et les croyances stéréotypées des élèves montre que de tels stéréotypes de genre diminuent avec la perception positive du comportement de l'enseignant.

Puis nous avons testé notre modèle « niveau trois et degré deux » (modèle de l'effet de l'enseignant) en prenant en compte les six sous-variables sur les attitudes envers les mathématiques. Ce modèle de l'effet de l'enseignant [χ^2= 189.24 (df=39), χ^2 normalisé = 4.8, NFI = 0.951, CFI = 0.961, RMSEA = 0.048] a aussi été validé ce qui montre une relation très forte de l'enseignant avec le développement de la croyance et de l'intérêt des élèves en mathématiques. Les pistes causales dans ce modèle ont montré que l'influence de l'enseignant passant par le concept de soi et l'auto-efficacité en mathématiques des élèves développe un effet positif significatif sur la variable « plaisir ». De plus, nous avons observé que cette variable « plaisir » crée une relation causale directe avec deux autres variables « utilité globale » et « amour des mathématiques ». Par ailleurs, en passant par ces variables, la variable « amour des mathématiques » développe un effet de causalité indirecte sur les variables « croyance-besoin » et « croyance-développement intellectuel » respectivement.

À travers cet ordre séquentiel du développement des dimensions, nous avons exploré dans cette étude que le facteur « plaisir » est le prédictif le plus influent dans le processus de la formation de l'attitude envers l'apprentissage des mathématiques.

Conclusion :

En abordant la question de la formation des attitudes des élèves envers l'apprentissage des mathématiques sous l'influence des facteurs sociaux (parents et enseignants), nous explorons les relations de causalité entre les variables (endogènes et exogènes) pour la compréhension des perceptions des élèves à travers ces variables. Afin d'explorer l'engagement des élèves dans les mathématiques, nous étudions comment ces perceptions des élèves varient selon le genre et avec l'environnement familial défini par l'éducation des parents et la nature de leur occupation. Nous concluons à partir de cette recherche que les différences des attitudes des élèves en mathématiques selon le genre sont causées par les besoins sociétaux et les attentes développées par les parents et les enseignants. Les parents influencent également parfois les croyances sur les stéréotypes et influencent donc de manière différente les filles et les garçons.

Par ailleurs, lorsqu'un élève entre avec des croyances subjectives et un certain niveau de confiance basé sur ses expériences antérieures, la pédagogie des enseignants en mathématiques, et leur comportement altèrent ou renforcent l'intensité des engagements de cet élève vis à vis des mathématiques, en modifiant ses croyances sur lui-même. De plus, en ce qui concerne nos hypothèses dans le modèle général incluant toutes les variables, nous avons trouvé que les enseignants en mathématiques influencent plus les concepts propres des élèves en mathématiques et l'auto-efficacité que ne le font les parents, tandis que les croyances stéréotypées des parents causent des croyances stéréotypées chez les élèves.

En outre, dans le cadre des attitudes en mathématiques, la direction de causalité a été trouvée significativement meilleure de l'intérêt vers les croyances, c'est-à-dire de la composante affective vers la composante cognitive. Ceci contredit les résultats des recherches antérieures où la significativité est meilleure de la composante cognitive vers la composante affective (McLeod, 1992; Ma & Xu, 2004a).

Grâce à l'analyse dimensionnelle du concept d'attitude envers les mathématiques, qui a été proposée dans cette recherche, cette étude offre matière à réflexion pour revoir ce concept plus finement. Concernant le concept de l'attitude envers les mathématiques, la dimension

« plaisir pour les mathématiques » liée à l'intérêt s'est révélée comme étant une variable d'influence qui joue un rôle important dans la formation d'autres dimensions de l'attitude.

Par conséquent, les conclusions de cette étude ouvrent la porte à revisiter la conception des mathématiques dans ses dimensions et elle encourage aussi à explorer d'autres dimensions de ce concept. Toutes les études qui ont déclaré des attitudes plus positives des garçons que des filles en mathématiques aboutiraient-elles aux mêmes conclusions si on applique notre analyse dimensionnelle ?

En plus, ces résultats sont intéressants en regard du problème de sous-représentation des filles en mathématiques au niveau de l'école secondaire supérieure et au niveau avancé, qui a été découvert dans la revue de la littérature. En effet, nous montrons dans notre étude que l'attitude positive des filles envers les mathématiques est essentiellement liée à leurs croyances en ce qui concerne l'utilité pour besoin financier et personnel, alors que celle des garçons se base sur leur intérêt en ce qui concerne le plaisir en mathématiques. Si l'on rapproche la sous-représentation citée plus haut de nos observations, peut-on proposer l'hypothèse que cette croyance ne serait que temporaire? Alors que l'intérêt pour les mathématiques qui conditionne fortement l'attitude positive des garçons serait plus durable? Est-ce que les filles reportent à un moment donné sur d'autres matières ce sentiment d'utilité ?

Par ailleurs, le plaisir en mathématiques qu'éprouvent d'après nos résultats majoritairement les garçons reflète-t-il les circonstances sociétales qui privilégient les garçons dans toutes les sociétés ?

En plus de ces questions, on peut encore se demander ce qu'il en est d'une égale possibilité d'accès pour les filles et les garçons aux écoles et à l'enseignement supérieur. Des recherches sur ce sujet seraient sans doute particulièrement pertinentes dans le contexte du Pakistan qui est confronté en même temps à la modernité et à de strictes contraintes sociales et à des valeurs traditionnelles en ce qui concerne les discriminations de genre. D'autres facteurs sans doute importants pourraient être étudiés comme le rôle des pairs ou des camarades dans la socialisation d'un élève, ou encore l'acceptabilité par la société de la présence des femmes dans les *professions traditionnellement masculines.*

Abstract

In mathematics education, research in achievements and attitudes reflects that mathematics learning, which lies in the nexus of attitude on one end, and achievement on the other, in general, constitute by the thought and perception that the students hold. Reflection of research, specifically in cognition and social domain, demonstrates that these perceptions of the students derived from the meanings; meanings that the things have for them. Insofar as attitude is concerned, the meanings of the physical objects and relation among them when constructed through the social interaction and the experiences that a person encounters, develop into the specific attitudes towards the objects. These attitudes may further guide the actions of human beings. In mathematics education research, theoretical framework on epistemological grounds was not given enough attention (Di Martino & Zan, 2001). Therefore, in this study, theoretical conception of mathematics attitude was proposed. It was assumed that mathematics attitude is based on two constructs, mathematics interest and mathematics belief, on the bases of which, a student can make an evaluative judgment about mathematics and her or his learning in this discipline. Thus, the definition of mathematics attitude was proposed as; *A positive or negative evaluation of mathematics on the bases of one's interest and belief in it is called mathematics attitude.*

The construct mathematics interest is defined in three dimensions, that is, psychological state of situational interest, liking & value, and interesting disipline, whereas, mathematics belief is delineated in global utility, intellectual development, and mathematics need belief (like, financial and self-actualisation) belief.

Formation of attitudes towards learning mathematics: The principal question and research objectives of present study

Research in mathematics education based on the belief that 'the capacities to do mathematics are highly affected by the attitudes that students hold, has been motivated under the social-psychological approach (Blondin & Lafontaine, 2005; Fennema, 1981; Jones, et al., 2000). The major emphasis of this approach was to discover the relationship between the achievements in mathematics with the attitudes towards this discipline. Research concluded that students' interest and value attribution of Mathematics are in fact the main ingredients in the formation of students' attitudes towards this discipline, which in result predicts the students' participation and success in this subject. However, how mathematics attitudes develop among boys and girls under certain social conditions, and why there are differences in their attitudes' intensity, is still to address especially in the light of social and cultural differences. Therefore, in the present study, this complex phenomenon of formation of mathematic attitude was addressed under the influence of social variables which provides a child an environment to develop her or his perceptions about herself or himself and of others. Based on these variables, a theoretical model of the formation of mathematics attitude was proposed. In this model, it was hypothesized that students' evaluative inclinations, feelings, and perception about mathematics, in general, and about his capabilities to do mathematics in particular, are the results of her or his private knowledge, which is constructed in the consequence of communication with inter-personal, psychological and social factors (including parents and teacher). The past affective reactions of student to the mathematics

that provides the basis to constitute the feeling (negative or positive) and intentions to do mathematics, moreover, the memory of prior beliefs she or he has about mathematics, and her or his capacities transferred by the parents and teacher, define the attitude towards learning mathematics. Hence, the specific objective under this principal objective of this research was to explore the causal relationship among the student's perception of social agents (parents and mathematics teacher) and student's self-beliefs variables in the formation of her or his attitude towards mathematics and learning this discipline. In addition, differences among the students regarding their mathematics attitude on the base of their gender, age, parents' education, and profession, were also aimed to explore in the pakistan's context. To achieve these major objectives following research methodology was adopted.

Research Methodology: This research had two major axis of objectives: first dealt with the conceptual framework of mathematics attitude and visualisation of theoratical model of mathematics attitude formation. Second axis addressed the research work in order to search the answers of research questions given above. This second axis therefore, had two tiers; first dealt with the development of appropriate scales to measure the attitudes of the students towards mathematics, their perception about influence of other social agents and their self beliefs. At second level, research questions were addressed and models were estimated with the help of emperical data.

To develop an instrument that addresses factors, styles and language which prevail in Pakistani society, a pre-pilot survey was conducted in order to collect the relevant information. Total 94 university students, belonging to graduate and master programs of mathematics, were participated in this survey and responded to the questionnaire based on open questions and a checklist. This data was analyzed qualitatively and the items banks consisted of 89 items were created for the four scales aimed at measuring the perception of students' about parents' influence, teacher's effect, mathematics self-beliefs, and mathematics attitude. These initial scales, which were based on 5 points Likert's scale, were then refined through content validity process and 77 items were left. To extract the factors and measure further the reliability of these scales, a pilot survey was conducted in three cities; Islamabad, Lahore and Sargodha. Total 234 students of age 10-11 years and 13-14 years from four government schools participated. At the next stage, Exploratory Factor analysis was used to sort out the factors measuring same characteristics. In result, total 14 factors were extracted from these scales; six factors from mathematics attitude scale, three from parents' scale, three from teacher's scale, and two from self-belief scale, while an additional scale "males are best in maths" was taken. Later Cronbach's Alpha coefficient was calculated for measuring the internal consistency of each scale by using SPSS v.17 software.

Finally, these developed four scales along with an additional scale "males are best in maths" based on 57 items were administered in ten urban schools (public and private) of two cities, Lahore and Sargodha, in the final survey. Total 1499 (678 Girls & 821 Boys) students from grades 6 and 9, were participated in the final survey of the present study. Out of total sample, 751 students (Girls = 397 & Boys = 354) were from grade 6 whose average age was calculated at 11.30 years, and 748 students (Girls = 281 & Boys = 467) were from grade 9 who were of average age 14.34 years. The data collected was treated (editing, entry and refining), and analyzed through SPSS, while AMOS v.18 was used for model testing and estimation. To analyze the data in the light of the research questions and hypotheses, descriptive statistics, multivariate analysis and Structural Equation Modeling techniques were used.

Results: Descriptive statistics for all factors demonstrated that students hold overall positive attitude towards mathematics. As this study was conducted on both boys and girls from two age groups and were belonging to different socio-economic status, therefore, gender was the major moderator variable. In addition, age and parents' socio economic status (including parents' education & occupation) were also assumed as moderating variables. To verify the principal and assumed moderators statistically, the homogeneity assumptions for the parametric test were tested and satisfied statistically for mathematics attitude, [F (1, 1278) = 3.848], for mathematics belief [F (1, 1393) = .001], and for mathematics interest [F (1, 1350) = 6.398] for p > .01 regarding gender.

In addressing the research questions of the current study, ANOVA was applied on the data to check gender differences for mathematics attitude and its constructs. Results demonstrated that boys and girls were significantly different in "mathematics Need belief" [F (1, 1471) = 9.507, p< .001], and in "enjoyment" under mathematics interest [F (1, 1469) = 4.503, p < .05]. Concerning age effect, when data was analyzed, elder students (grade 9) showed significantly more positive attitude towards learning mathematics [F (1, 1278) = 4.996, p < .05] as well as in its component "mathematics interest" [F (1, 1350) = 14.714, p < .001] than younger students (grade 6). However, for mathematics belief, difference between the students was not found statistically significant. Later, data was analyzed according to six dimensions of mathematics attitude. Mathematics belief, which was appeared non significant for students of both age groups, for its sub-variable, "belief of intellectual development", grade 9 students demonstrated more positive belief than grade 6 students [F (1, 1441) = 5.882, p < .05]. While, in "mathematics need belief", students of grade 6 showed significantly more positive attitude [F (1, 1471) = 16.689, p < .001].

Lastly, concerning the effect of parents' socio-economic status on the development of mathematics need belief, univariate ANOVA was performed on the data. Four groups of students according to father education level were found significant [F (3, 1443) = 5.425, p < .01]. Through Boneferoni Post Hoc test, students of two groups ("No education" and "Higher education") were significantly different in this belief. Students from families where father was either illiterate or having primary education, were holding significantly more positive belief in mathematics as a source of getting scholarship, good job and self-recognition than the students of "father with higher education". Further analysis demonstrated that there were more females than males who believed this aspect.

Similarly, mother's education was also appeared as a significant variable for the development of this dimension of mathematics attitude [F (3, 1447) = 4.757, p < .01]. Students whose mothers were having no or primary education were holding more positive attitude towards "need" factor of mathematics than those, whose mothers were having higher education. On contrary, father's occupation was not found a significant factor for this belief. However, students from "father with teaching profession", though were in very small propotion, but demonstrated significantly positive Mathematics Interest than the students from other groups. These results indicated that low level of education of parents and limited resources accelerate mathematics need belief.

On the next stage, towards the validation of the mathematics attitude formation model, the correlations of the factors were first computed. Significant correlations among the factors were found that indicated the existance of significant causal paths among the variables. Hypothetical general model at level-1 and degree-1 (collective effect of all factors under each variable) was checked and found that the sample data best fit the model [χ^2=1.695 (df=1), normed chi-square = 1.695, NFI = 0.999, CFI = 0.999, RMSEA = 0.022]. All absolute, normed and parsimony indices demontrated that the theoretical model, presented in this study, does exist and hence the second major research question was satisfied. This model was further analyzed at level-2 & degree-1 (with 6 exogenous sub-variables, 3 mediating variables and 2 endogenous variables under mathematics attitude). All Fit indices were found within the acceptable range (except normed chi-square, which may be because of the variation in the data regarding gender and socio-economic status), which ensured that at this level too, the model of this study fits the data moderately [χ^2 =386.315 (df = 63), NFI = 0.907, CFI = 0.919, RMSEA = 0.05].

The model of this study was later hypothesized at level-3 (teacher's influence model) and degree-2 (along with all six sub-variables of mathematics attitude). The model of teacher's effect was tested and was found best fitted [χ^2= 189.243 (df=39), normed chi-square = 4.8, NFI = 0.951, CFI = 0.961, RMSEA = 0.048]. The causal paths in this model showed that teacher's influence mediated through student's mathematics self-concept and self-efficacy developed a significant positive causal effect on "MIE". This variable "MIE" created a direct causal relation with further two variables "MBU" and "MIA". Moreover, passing through these variables, the variable MIA developed an indirect causal effect on variables "MBN" and "MBI" respectively. Through this sequential order of the dimensions, this study explored that, MIE, that is, "enjoy doing mathematics" is the most influential predictor of the formation process of attitude towards learning mathematics.

Conclusion: In addressing the question of formation of attitudes of students towards learning of mathematics under the influence of social agents (parents and teacher), this study explored the causal relationships between the variables (endogenous and exogenous) in the light of students' perceptions of these variables. In order to study the student's engagement with mathematics, this study examined that how these perceptions of students alter with gender and with social environment based on parents' education level and nature of their occupation. This research concluded that differences in mathematics attitudes of students regarding their gender is caused by the societal needs and expectations developed by parents and teachers which also sometimes invade stereotypic beliefs, and thus, affect a boy and a girl in different ways. Moreover, in the classroom, when this student enters with her or his subjectivities of beliefs and certain level of confidence based on her or his experiences with the background variables. Mathematics teacher with pedagogy, encouragement and behavior alter or strengthen the intensity and direction of student's engagement with mathematics mediating through her or his mathematics self-beliefs. In addition, concerning the research hypotheses within the general model of all variables, mathematics teacher effect was found more influencing on students' mathematics self-concept and self-efficacy than parents, whereas, parents' stereotypic beliefs caused stereotypic belief in students. Moreover, as the constructs of mathematics attitude, the direction of the causality found better from mathematics interest to mathematics belief, that is, affective component caused cognitive component more significantly in this research. This finding contradicts the results of previous researches claiming sequential order of cognitive over affective component (McLeod, 1992; Ma & Xu, 2004a). These findings are opening the doors for new investigation to explore the issue of low participation of girls in mathematics in the context of cognitive and affective components. Because if the results of gender differences are compared with the causal effects of the dimensions of mathematics attitude, then can we assume that belief construct is temporary which divert to other fields of study than mathematics? Or, interest in mathematics is more dureable and consistent component of mathematics attitude, which brings the students towards this discipline at advance levels? Or, these are the oppurtunities and social circumstances which prevelige one gender over other? These reflections of the current research initiate further investigations in these premeses, along with the contribution of other social variables, like, peer or friend role, mathematics achiements, school systems, etc., in the context of Pakistan.

SECTION ONE: REVIEW OF THE RELATED LITERATURE

Chapter.1 Introduction to Mathematics Attitude

1.1 Introduction

In mathematics education, research on mathematics learning, lies in the nexus of attitude on the one end and achievement on the other. This learning is highly affected by the thought and perception that a student holds about his competency in this discipline. Reflection of research specifically in cognition and social premises, demonstrates that these perceptions of the student derive from the meanings; meanings that the things have for him. Insofar as attitude is concerned, the meanings of the physical objects and relation among them when constructed through the social interaction and the experiences that a person encounters develop into the specific attitudes towards the objects. These attitudes further may guide the actions of human beings (Blumer, 1969, p.2).

The other predominant debate in the field of mathematics education has been the *gender differences in the attitudes towards mathematics* and their effect on the success and decision of adopting this discipline as major. A stream of research studies (cf. Annett's Theory, 1985 &1995; Nuttall et al., 2005) affirmed gender differences in mathematics learning based on achievement. In explaining the phenomenon of these differences, various reasons were pointed on the biological and psychological grounds and hence established bio-psychological theories (cf. Halpern et al., 2005). But for the past few decades, research based on the belief that "the capacities to do mathematics are highly affected by the attitudes that students hold" was motivated under the social-psychological approach to address the gender issues in it (Blondin & Lafontaine, 2005; Fennema, 1981; Jones et al., 2000). The major emphasis of this approach was to observe the gender differences in mathematics attitude. Further, how boys and girls differ in their attitudes towards this discipline was addressed under certain social conditions and gender segregation of the society. Later, in the light of this context, the causes of mathematics avoidance and discontinouation of this discipline at advance level were initiated to explore. But how such attitude develops which becomes the cause of this situation and how boys and girls are different in the development of their attitudes towards learning mathematics, much work is needed to be done and in addition, in different cultutal scnerios. Therefore, current study is aimed at exploring this phenomenon of development of mathematics attitude under the causal relationships of social and psychological factors, which is still hidden in the context of Pakistan.

But, before addressing the issue of formation of such mathematics attitudes and their effects, it is worthwhile to study that, what the attitude is, in general, especially in the field of mathematics education, how it is seen.

This chapter is focused to gain insight of the literature on different concepts of attitude in general, and then specifically in the premises of mathematics education. Our next aim in this chapter, is to propose a conceptual framework of mathematics attitude for present study, because theoretically comprehensive framework of this construct in the domain of mathematics education is not given enough concentration in research and still needs to work out a lot (Di Martino & Zan, 2001; Hannula, 2002).

1.2 Concept of Attitude

The metaphor 'attitude' came from the theater late 19th century which described attitude as a body posture, a pose, a way of physical expression and sometimes it is cited in Arts (Fazio, 2007) where it is used to refer to the *posture of a figure in a painting or sculpture* (p.2). The very first usage of this connotation in a formal domain of studies can be seen in late 19^{th} century in the reaction time studies regarding perception & memory in experimental psychology. Numerous studies in this domain revealed that those participants who were mentally prepared to press the telegraph key upon a signal were more efficient in response as compare to the other respondents who focused their attention on incoming signals. In these studies this preparedness to respond was referred as "task-attitude" or "mental set" (as cited in Fazio, 2007). This term was particularly borrowed to social psychology in 1888 to express the mental state to demonstrate, and was referred to the 'posture of mind' (Mucchielli, 1988, p.8). Since then, the word 'attitude' is being used widely in daily life speech with slang meanings to express the feelings, emotion, behavior, etc. In social psychology, the study of attitude covers a major portion and has been a central concept of this discipline for long a time that Thomas and Znanieki (1918) defined the field of social psychology as "the study of attitudes".

The concept of attitude has evolved over time and in different dimensions. In modern times, we can observe that different disciplines have approached the study of attitudes in rather different ways that made this notion as an interdisciplinary concept. The main disciplines that claim it as the part of their subject matter are sociology, political science, communication research and psychology (Oskam & Shultz, 2005, p.15). Researche studies in these domains have done magnificent work on attitude and developed variety of theories, models and approaches in this field of study. In the field of education and pedagogy it has attained enormous attention in teaching-learning process to discover the approach of learning and explore the impact of other factors, psychological and sociological, on the development of attitudes and opinions.

Here, we present briefly different themes that are assumed to define the metaphor attitude as a concept.

1.2.1 Attitude – Mental state of Readiness

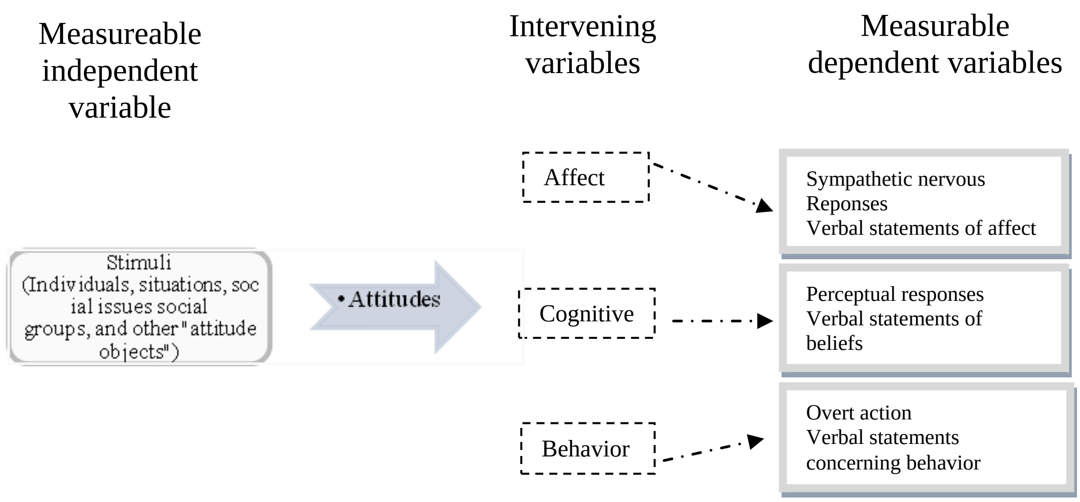
The study of attitudes has a long influential history, despite the venerability of this concept, there are conceptual differences in each viewpoint thus unanimity in what the attitude is and how it can be identified is somewhat elusive (McGuire, 1985). In 1935, while writing a chapter in the book of social psychology, Allport presented his influential analysis on the meanings and utility of the attitude. He synthesized common grounds of different viewpoints on this concept given by other sociologists and psychologists and proposed rather a comprehensive definition of attitude which is, no doubt, most cited one and famous definition among the prevailed definitions. He declared attitude as the "most distinctive and indispensible concept in contemporary psychology". According to him; "An attitude is a mental and neural state of readiness, organized through experiences, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related" (1968, p.16).

The central emphasis of his definition is the concept of "readiness of response" this feature refers to the early references of "readiness" in *task-attitudes*. It indicates the *"mental state"* for preparation for action or to respond in a particular way towards an object under certain conditions. For these preparations or inclinations there is the driving force (directive and dynamic) that depends on the past experiences of the person regarding that object which further guide person's behavior or action accordingly. Thus, this idea presupposes "behavioral responses that are consistent with the attitudes". Herein lies a point of controversy that how we can observe such readiness of response in the absence of action as argued by Fazio (2007) that "the state of readiness influences a broad array of responses, which raises an important question. If no such influence is observable, then there is no attitude?" (p.2).

1.2.2 Attitude – Predisposition to Respond

The other concept of attitude is based on multi component view. The most well known definition in this cadre was presented by Rosenberg & Hovland in 1960. They viewed attitude as the "predisposition to respond in a particular way towards a specified class of objects" (p.1). They described this *predisposition to respond* in to three components namely: affective, cognitive and behavioral. According to this particular concept, what the feelings and sentiments we have, how we think and what ideas we possess and what are our inclinations to act, and in addition, actions about an object, form our attitudes.

Following diagram reflects the schematic concept of an attitude in terms of three components that is usually seen as "tri-partite" model:



Source: Rosenberg & Hovland (1960, p.3)

Figure 1.1.: Schematic Conception of Attitudes

In addition, the other feature that can be conceived from this definition is that, being predispositions, attitudes are not directly observable or measureable. As these response classes are attributions so, these can be inferred through verbal statements. To measure the affective response rather than using other psychophysical techniques like monitoring blood pressure and temperature of the body during conversation etc, a verbal statement of respondent regarding the intensity of his liking or disliking can be adopted. In the same way, for cognitive aspect a verbal statement expressing the respondent's perception or belief may lead us towards his attitude towards an attitude object. The other aspect emphasized by authors, in this model, is the behavior of the respondent, which can be deduced from the way one reacts towards the stimuli or his verbal statement about his decision to act in a certain situation.

Critics on this model of "three component conception of attitude" or "tri-partite" review that this model emphasizes heavily the existences of attitude-behavior relationship. But the evidences from the research done in this cadre proved that this relation was "tenuous" that made the theorists confused about the clarity of notion of attitude (Zanna & Rampel, 2008).

1.2.3 Attitude – An Evaluative State

Another view about the attitude construct can also be observed in the evolution period where researchers characterized attitude in terms of evaluation of objects according to the valence and extremity. In explaining the dimension of evaluation, Zanna & Rempel (2008) delineated that the stimulus judged against or compared with one or more objects as standards is described in the form of good or bad categories. This evaluation as the attribution of degree of goodness or badness to an entity, an attitude object, is an essential feature of attitude. The development of an attitude starts when an individual evaluates an attitude object based on his cognition or affect (Ajzen, 2001). These evaluative responses that express approval or disapproval, acceptance or avoidance, as the indicators of attitude, are different in terms of valence (positive/negative) and further in intensity (strong/weak) too. The traces of this characteristic can be found in earlier definitions too, for example, Thurstone (1929) suggested that attitudes are evaluative or affective responses to attitude objects. Chein (1948) called attitude as the disposition to evaluate certain objects, actions and situation in a certain way. This evaluative aspect of attitude in a simplest manner can also be observed from Bem's definition (1970) that attitudes are "likes and dislikes" (p.14).

The evaluative state is internal to the individual, which is formed under certain mental state and capacities to understand. These evaluative capacities to understand, depending on the cognitive and affective tendencies, can be seen in the definition given by Eagly & Chaiken in 1993. They defined that "attitude is a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (p.1).

In the above definition, attitude is accentuated on the evaluative state that is linked with the stimuli at one hand and class of responses on the other hand, whereas, psychological tendency lies on this residuum. This tendency predisposes an individual towards an evaluative state to judge the response in favorable or unfavorable manner. Once this evaluative representation is developed for an object; it stores in the memory as a source for the development of the attitude towards that object. On the other hand, Oskam & Schultz (2005) narrated attitude as a comprehensive state of respondents without specifying the boundaries of psychological stipulations. They remarked that "an attitude is a predisposition to respond in a favorable or unfavorable manner with respect to a given attitude object" (p. 8).

Thus, psychological tendency and significant pattern of responses as a result of mental evaluation, if analyze with the concept of attitude as *the predisposition*, in terms of interrelationship, then it reveals that this predisposition to respond is somehow a final output of the evaluation process. But in the explanation of the evaluative characteristic, Oskam & Schultz (2005) remarked that attitudes are represented in memory as a part of a person's knowledge structure. But how such knowledge constructs, which in results, causes an attitude, we need to study its relational locus of information that is linked with the person's internal and his contemporaneous external sources.

The assumption of the locus of information underlying the evaluative judgment of the object in the conceptualizations of the attitude has received empirical support (Chaikin & Baldwin, 2008; Eagly & Chaiken, 1993). As an internal source, the locus of information based on knowledge structure stores in the memory that also possesses prior beliefs, helps one's to associate some specific representation, attribute of, or emotional responses with an object. These affective states further linked with the evaluation of that object in favorable or disfavorable manner and provide the basis for learned predisposition to respond accordingly (Fishbein & Ajzen, 1975). Therefore, emphasizing on such learning consistency on the basis of the constructed knowledge, Fishbien & Ajzen (1975) defined attitude as a "learned predisposition to respond in a consistently favorable or unfavorable manner with respect to a given object" (p. 6).

Researchers (Chaikin & Baldwin, 2008; Fabrigar et al. 2005; Rhine, 1958) in sociology agreed that the integration of social perception and past affective reactions to the attitude object in this knowledge structure process, are of the essence as these somehow influence the information underlying attitude judgment.

The dimension of the attitude concept –"predisposition to respond" – "mental or neural readiness" – "evaluative state"—"learned predisposition", reflects that an attitude is a kind of mental organization which is built through experiences, that evokes a significant pattern of responses about an attitude object. Implication of attitude's concept in the field of education, especially in terms of attitudes towards learning opened new doors in educational research, rather narrowly, in mathematics education. This invasion of attitudes' study in mathematics education brought a restructuration of learning theories and introduction of intervention studies.

In the following part of this chapter, the conceptual framework of mathematics attitude proposed by different mathematics educationists is presented.

1.3 What is an attitude towards mathematics?

Research on attitude towards mathematics is significant part of the mathematics education whose origins are embedded in social psychology. L.L. Thurstone published a comprehensive piece of writing "attitudes can be measured" in 1928, since then, an abundant scholarship on the attitude's measurement enriched the study of attitude not only in social psychology but also in mathematics education. In mathematics education, attitude has always been believed to be crucial for the learning of mathematics (Neale, 1969). With this belief, a new horizon opened in mathematics education research to study the student's attitude towards mathematics and its measurement. How student's attitude towards mathematics influences his competency and learning in this subject, has received considerable research attention. The core object of such studies has been the analysis of relationship between performance in mathematics and attitudes towards learning this discipline. The other dimension of this field of study has been the determination of the possible correlation of career choice of the individuals with their beliefs in their mathematical capacities and attitudes towards mathematics.

It is widely accepted fact that cognitive as well as affective components in the form of attitudes must be investigated if understanding the process of mathematics learning is to be improved. Because, there is consensus on the fact that beliefs and emotions strongly interact, and thus, play a crucial role in recognizing as the cognitive and affective components of attitude construct (Eagly & Chaiken, 1993; Fazio, 2001; Fishbein & Ajzen, 1975; McLeod, 1992). This re-evaluation of cognitive together with affect in learning of mathematics boosted up a renewed popularity to the attitude concept in the domain of attitude research (Zan & Martino, 2007).

Though, critics (like; Zan & Martino, 2007) have quoted that there is a lack of '*theoretical framework*' available to develop the concept of attitudes towards mathematics, rather most of the work was done on the measurement of attitudes. But the question arises here that how one can measure an entity without refining its idea and defining its premises. Although, it is true that various studies conducted by researchers (e.g., Marjoribanks, 1987; Reynolds & Walberg, 1992) while measuring attitudes towards mathematics presented their results without giving a clear definition of attitudes towards mathematics or presenting the ontology of this construct. Nonetheless, it can be assumed that there are as many views of attitude towards mathematics as attitudes in general in social psychology.

Before proceeding further towards the theoretical framework of the concept of mathematics attitude that is developed for the present study, it will be interesting to review briefly already existing concepts of mathematics attitudes. After reviewing the available literature of the studies done on mathematics attitudes and their measurement, four main themes were found on which attitude towards mathematics/mathematics attitude[1] has been defined or considered.

- First theme is the three components or 'tri-partite' view whose roots can be found in classical view of attitude in social psychology (previously explained as *predisposition to respond*). According to this theme, attitude is a complex entity that can't be measured directly but through affective, cognitive and behavior components. Thus, student's feelings for, beliefs about mathematics in general, and the capabilities to do mathematics in particular, and her or his behavior

[1] For the ease of writing, we assume "attitudes towards mathematics" as "mathematics attitudes".

towards this discipline are called the attitudes towards mathematics (Triandis, 1971).

- Second view depicts the evaluative state based on the affect. This can be called a single component view of mathematics attitude. A vast scholarship of studies, supporting this idea, is available in the domain of mathematics education (Aiken, 1970; Hannula, 2002; Papanastasiou, 2000; Zan & Martino, 2007). According to this theme, student's sentiments, his liking and interest in mathematics are seen as attitudes towards mathematics. Thus, the degree of positive/negative or favorable/unfavorable evaluation of mathematics or doing mathematics is called attitude toward mathematics. Therefore, *'I like mathematics'* or *'I enjoy doing mathematics'* depicts one's mathematics attitudes.
- Third theme, which can be observed from research literature, is little bit a modified view of above-mentioned theme. In this approach, belief about mathematics is considered as an integral part in measurement of mathematics attitudes based on emotions. This approach borrowed to mathematics education from Mandler's theory about emotions. Mandler (1984) proposed that emotions always express some aspect of value and are seen in connection to personal goals. Thus they play an important role mainly in human adaptation and coping with the situations. Considering this thematic approach as bases, a series of studies (Richardson & Richardson, 1976, MARS[2] & MARS-A[3]) was carried out in mathematics education field on the subject of mathematics anxiety and test anxiety. The main objective of such studies was to explore the anxiety in mathematics and to evaluate its effect on the mathematical competencies: anxiety whose main source is emotions that ascribes to psychological reactions in a given situation. For example, Richardson & Richardson developed mathematics anxiety inventories (MARS) in 1976 to measure the level of anxiety of students in mathematics.

  Later, the direction of these studies moved towards attitudes considering *anxiety* as complementary part in developing the attitudes towards mathematics. Researchers took *belief* as complementary component together with this concept of attitude in studying the mathematics attitudes and their effect on the achievements. One possible reason of the inclusion of belief along can be that,

[2] Mathematics Rating Anxiety Scale.
[3] Mathematics Rating Anxiety Scale-Adolescent

emotion includes other psychological reactions too thus can't be the consistent depicter of attitudes. Hannula (2002) explained this phenomenon in following words:

> There are at least two fundamentally different ways that stimulus may change emotional state. One way is the cognitive (possibly unconscious) analysis of the situation with respect to one's goals. Another route to change emotional state can be learned via classical conditioning. This learned automatic associative route between the stimulus and the emotion has an important role with respect to the simple definition of attitude as an emotional disposition. (p. 28)

- Another concept of attitude that can be observed in literature is *bi-dimensional* definition in which, affect and cognitive components are clearly assumed as the student's emotions and their beliefs related to mathematics. Combining together these two components are seen as mathematics attitudes. In this concept of attitude, behavior was not considered as the part of attitude, thus did not take it in account while measuring attitudes (Ma & Kishor, 1997). On contrary, Pehkonen (2003) placed beliefs in the "twilight zone" which is somewhere on the residuum of human's affective and cognitive domains and argues that 'beliefs' as the individual subjective knowledge is the component of both affective and cognitive domains (as cited in Kislenko, 2005).

1.4 Mathematics Attitude

In mathematics education, student's evaluative inclinations, feelings, and perceptions about mathematics, in general, and about his capabilities to do mathematics in particular are the results of his private knowledge. This private knowledge constructs in the consequence of communication with inter-personal, psychological and socio-cultural factors. The past affective reactions of student in mathematics that provides the basis to constitute the feeling (negative or positive) and intentions to do mathematics, moreover, the memory of prior beliefs he has about mathematics and his capacities, are the determinants of his mathematics attitude.

Therefore, for our study, we assumed that mathematics attitude is developped on two constructs, mathematics interest and mathematics belief on the bases of which, a student can make an evaluative judgment about mathematics and his learning in this discipline. Thus, we propose the definition of mathematics attitude as:

> *A positive or negative evaluation of mathematics on the bases of one's interest and belief in it is called mathematics attitude.*

To elaborate the concept and premises of mathematics attitude, the conceptual framework of the proposed constructs; mathematics interest and belief is presented below.

1.5 The construct of Mathematics Interest

Interest plays a vital role in the process of learning and is sometimes considered as the motivational factor in the students' engagement in the educational process. Some authors considered even an individual's interest as attitude (cf. Aiken, 1970; Gardner, 1975; Papanastasiou, 2000). Krapp et al. (1992) remarked that "in Social psychology, the concept of interest as a vocationally relevant disposition, is closely related to the concept of attitudes" (p.6).

There may be various concepts of interest but for the proposed concept of mathematics attitude of the present study, we adopted the characteristics of this view presented by Krapp et al. (1992) in order to explain our construct of mathematics interest. We proposed a three-dimensional view of mathematics interest in which this construct will be delineated for mathematics attitude. These are psychological state of situational interest, interestingness and, liking and value, as given below.

- Psychological state: it consists of situational interest and actualized individual interest. Frenzel et al. (2010) referred it as a state and a trait character respectively. In mathematics, novelty of concept, complexity of mathematical problem or ambiguity in solution method, if works like stimulus, leads to the curiosity and urge of exploration. These resultant outcomes trigger a situational interest in doing mathematics. For example, the statement, *Mathematics problems are like games to me which I want to play*, demonstrates the interest and curiosity in solution of problem. For instance, research showed that those students, who reported mathematics as uninteresting subject, in general, after exposing to learning through some activities or some project, admitted mathematics as interesting in learning (cf. CAME[4] & CASE[5] studies, etc.).

Whereas, trait character or individual habitualized character is related to that interest which is relatively stable in nature for a longer period of time and the possibility of change is rare. It is associated with the increased knowledge, thus, can vary in terms of intensity with respect to various difficulty levels and complexity in mathematics. For example, students who claim to have interest in mathematics may not have same level of interest for all domains of mathematics. This type of individualized interest is pertinent to explore mathematics attitudes of students towards particular career path related mathematics or for specialization in any domain of mathematics, e.g., pure mathematics, applied mathematics, financial mathematics, etc. Here, delimiting the present study, we do not consider this dimension of interest.

- Characteristics of the interestingness or agreeable: this is a domain specific approach, which deals with the interest in adopting a specific discipline in a learning environment. The students from science domain may not have same interest in all disciplines offered in the class. Therefore, for mathematics interest in the premises of the present study, general liking for mathematics (mathematics is agreeable) or in opposite sense disliking mathematics is dealt as the characteristic of interestingness/agreeable. For example, the statement, *I dislike mathematics even if I get good marks*, talks about the level of interest in mathematics as discipline. Further, *mathematics makes me tense and uncomfortable*, represents mathematics as a troublesome and annoying discipline for particular students. These interests at advance levels in education help in specifying the line of the profession for the future career thus deal as a source of life aspiration.
- Individual interest as a disposition: it is conceptually dealt with the liking and value of mathematics. Frenzel et al. (2010) remarked that one may experience enjoyment in interest-triggered situation that further relates to the individual’s preference for the action. This approach of interest shares the common boundaries of value and hence seems one of the value components (cf. Eccles et al., 1983), for example, *I like mathematics because we can get good marks*. This sentiment

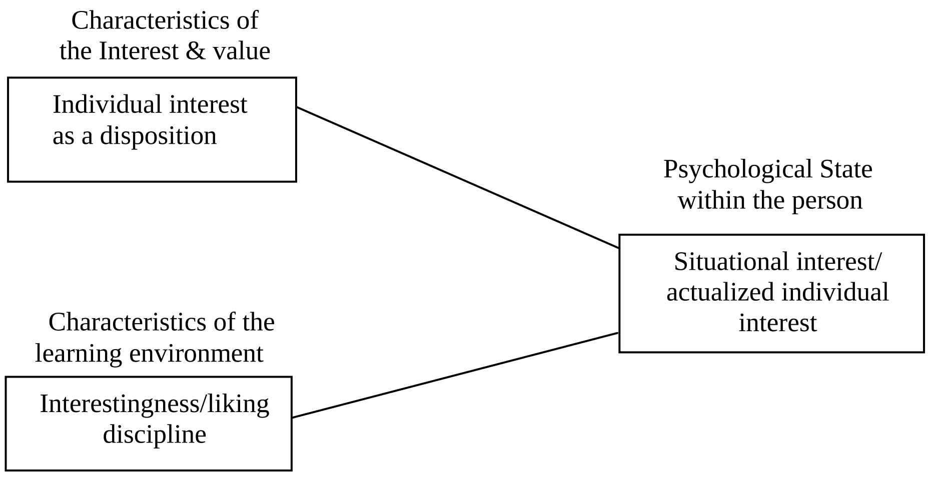
[4] Cognitive Acceleration in Mathematics Education (CAME)

[5] Cognitive Acceleration in Science Education (CASE)

deals with level of enjoyment there it depicts the value belief about mathematics too.

These three dimensions may be interrelated with each other but most influencing and independent dimension is the situational interest because it deals with the individual's interest at micro level of doing mathematics problems. If one demonstrates interest in this dimension then it can be expected interest in other dimensions too.

To understand the interrelationship among these dimensions, the conceptual diagram in Figure 1.2 illistrates the communication among these forms of interests.



Source: Krapp, Hidi & Renninger, 1992 (p.10)

Figure 1.2. Model of three approaches to interest

1.6 The construct of Mathematics Belief

Generally speaking, *belief* is what we think to be true. The unclear and inconsistent definitions of mathematical belief often mislead the readers (or researchers) in differentiating knowledge that we preserve, and the beliefs that we hold (Cooper & McGaugh, 1968; Pajeres, 1992; Törner, 2002). Therefore, "on numerous occasions, beliefs have been, and still are, related to notions of misconceptions" (Törner, 1998, p.74).

Our focus here is to explain the construct of mathematics belief that we considered in our conceptual definition of mathematics attitude for present research. For delimiting the conceptual framework of this construct, the standard references of Eagly & Chaiken (1993), Törner (2002), Pajares (1992) and Thompson (1992) were consulted.

We noted previously that an attitude is an evaluative state about an attitude object, whereas, belief functions as the linkage between the attitude objects and the attributes (cf. Fishbien & Ajzen, 1975). Schoenfeld (1998) rather used the process of codification and explained beliefs as mental codification that people experience or understand about an entity. A step further, while taking attitude as the point of reference, Eagly & Chaiken (1993) quoted that beliefs are basic building blocks of attitudes. They proposed "beliefs are associations that people establish between the attitude object and various attributes" (p.103).

Törner (2002) reported belief object to anything that shares a direct or indirect connection to mathematics. In the current study, we would rather use the term "mathematics belief" to specify the beliefs particular about this discipline. Thus mathematics belief can be assumed as:

> *"An evaluative association between the mathematics as discipline and various attributes that students establish".*

To understand this association, it would be pertinent to explore the structure of the mathematics belief because cognitive memory patterns and their links are related via the internal network structures of beliefs (Törner, 2002, p.86). Therefore, as a complex entity, belief structure deals with different dimensions that somehow share different approaches (e.g., discipline specific, content or domain specific, etc). In addition, Cooper & McGaugh (1968) also remarked that, "stimulus object of a belief is relatively complex even though this may mean that the subject has differentiated the object into smaller and smaller sub-regions" (p.26). Therefore, understanding structures of belief networks, this concept may be differentiated with respect to different classifications of mathematics as a discipline, content related, etc. in current study. Here, it is categorized in two main streams:

a) Subject Specific beliefs (cf. Törner, 2002)

b) Self Specific beliefs (cf. Eagly & Chaiken, 1993)

Though both streams, together, encompass the complete idea of mathematics belief but for the conceptual framework of mathematics belief as the construct of mathematics attitude, present study will consider subject specific belief only, whereas, self specific mathematics beliefs are studied separately under the term ‘inter-personal beliefs or mathematics self-beliefs’ which is discussed in the next chapter.

1.6.1 Subject Specific beliefs

Subject specific beliefs, as name depicts, are overall about the discipline. This category can be further divided into three types:

- Subject specific global beliefs
- Subject-matter beliefs
- Domain-specific beliefs

Under this category, the present study is delimited to the subject specific global beliefs only in order to define the premises of mathematics beliefs for the development of mathematics attitude under the social influence. Therefore, here we explain first, the global beliefs.

Subject specific global beliefs

Mathematics global beliefs are the general beliefs about the nature of the mathematics in terms of usefulness. We will discuss this belief of mathematics in three dimensions:

- Global usefulness belief
- Intellectual belief
- Personal utility belief

- Global usefulness belief of mathematics deals with the importance and utility of mathematics in society. It is related to the application and contribution of mathematics in science and technology. Thus, students’ belief about mathematics’ utility for the technology advancements, in general, thus consider this discipline as obligatory for the economical development of the country comes under this type. For example, statement like, *there is no technology without mathematics*, can measure students’ mathematics attitude based upon this belief. This belief can also be judged in school regarding the importance of mathematics among school subjects.
- Second type, intellectual belief of mathematics, addresses the usefulness of mathematics in the intellectual development of person. This category deals with

the belief that mathematics provides such mathematical environment that fosters student's thinking abilities, inculcate multidimensional thinking skills through complexity of mathematical problem, and search for plausible solution approaches. For example, *Mathematics helps in developing a person's mind and teaches him how to think*" etc. depicts the traces of this belief. Therefore, student's belief that mathematics is practical, creative, and thinking skills oriented discipline, forms his attitude towards learning mathematics.

- The third dimension under this category addresses the mathematics utility belief for personal benefit that includes financial benefits or self-satisfaction. Students' belief that mathematics can provide a wider scope in the job market as a quick source of income in form of part-time job; or adopting this discipline as future career can provide permanent financial benefits. Both types of perceptions falls in this type. Such beliefs become the motive to adopt this discipline for higher studies.

The other categories of mathematics belief, though, are out of scope of this study to explore under the tag of mathematics attitude but for the sake of better understanding the distinction between them, we briefly described them below.

Subject-matter beliefs

The other form of the mathematics belief under subject specific category is related to the subject matter or content-knowledge that can be termed as "*subject-matter beliefs"*. Students sometimes believe that they have competency in certain content conception; therefore, such beliefs lead them to use some particular method to approach the solution of the problem. For example, solution of equations by using matrix method or tradition methods (computational or comparison methods), problems of triangles (like; altitude or angle) by axioms or trigonometric skills, to approach the solution of a word problem by recalling some formulae or some other conceptual skills etc. This type of belief, which particularly deals about the utilization of mathematical skills for the solution of the problems, is out of scop of our research objectives.

Domain-specific beliefs

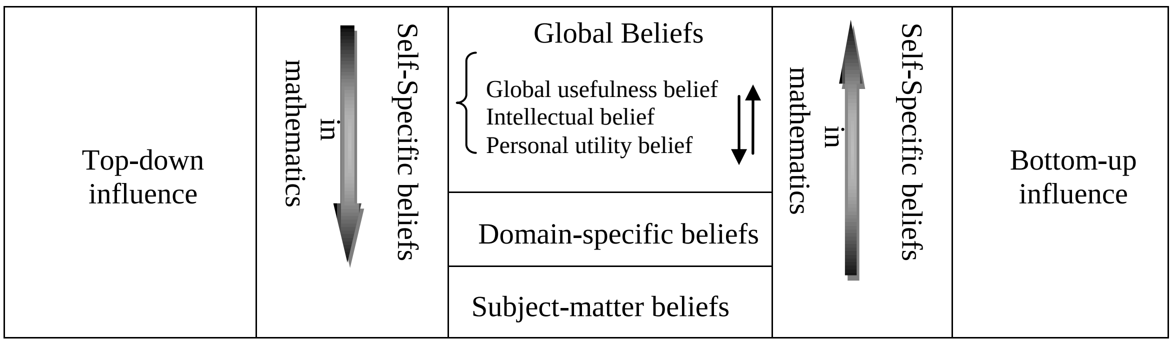
Third category "*domain-specific belief"* deals with different domains of mathematics, like; calculus, geometry, algebra etc. Generally, a student does not have the same belief about every domain of the mathematics regarding its importance and usefulness. Therefore, students make choices on the basis of these beliefs in selecting the courses at advance levels. Even at secondary level, a student who has global belief of importance of mathematics does not necessarily have same intensity of the belief towards every domain of the mathematics. This situation, in result, leads to the specific belief about the subject matter.

1.6.2 Self-specific beliefs

The individual's personal beliefs about his learning capacities and perception of his ability to do mathematics, in general, are termed as self-specific beliefs. In general, we can assume self-concept and self-efficacy related beliefs in this category. Student uses such beliefs as a basis for predicting their competencies in accomplishing the task and achievement probability in exams.

In the present study, this category of belief has been taken separately as the part of inter-personal beliefs and hence is not included in the conceptual framework of mathematics attitude.

Above-mentioned forms of belief, though fall in different categories, but together explain the belief system consists of interdependency among these forms of beliefs. Figure 1.3 presents the mechanisim of all dimensions and forms of belief concept in the belief system.



Source: Idea taken from Törner (2002), p.87.

Figure 1.3. Communication between three dimensions of Mathematics Belief

This belief system demonstrates the hierarchy of different belief categories in which it is shown that how different categories of mathematics belief communicate in the belief system. In the center, the core part of this belief system consists of three main beliefs related to mathematics, which represent the causal relationship among them. This causal effect moves in two directions top to down and down to top in the presence of self-specific beliefs. The presence of self-specific beliefs demonstrates that this belief system does not work in isolation within the premises of mathematics only. These beliefs and interest in mathematics, which formulate the evaluative judgment called attitude towards mathematics, develop within a person under the influence of the physical environment and in relation with the units of the society. The next chapter of this section encompassed these units within which a student lives and develops his attitude towards mathematics.

Chapter.2 Formation of Mathematics Attitude and Influencing Factors

2.1 Introduction

Attitudes are usually learned from the environment and experiences. But how these are learned, we explained in previous chapter the process of knowledge structure that it includes. This knowledge structure and process of information on the base of which an evaluative judgment is made and thus an attitude is formed, depends on the numerous factors (endogenous or exogenous). These factors are essential to the process of formation of attitudes. Oskam & Schultz (2005) defined attitude formation process that "it is the process by which an individual develops a favourable or unfavourable evaluation, based on experiences, of an object" (p.162).

The term attitude formation, in fact, is an initial change from having no attitude to having some attitude towards an object. This situation of initial change, which leads to the formation of attitude, is described by William James as; "blooming, buzzing confusion" for a child (as cited in Oskam & Schultz, 2005, p.161). Thus, such information and feeling about the object, which is "blooming" for the child, leads him to evaluate it in the form of favorable or unfavorable (Oskam & Schultz, 2005).

Therefore, in case of mathematics, we can suppose that, the formation of attitude towards this discipline and its learning is linked with the feelings develop the very first day of a child when he is introduced numerals; a small step towards learning mathematical abstractions. However, early experiences in, and information about mathematics, as the source of knowledge construction, may not be accompanied by an evaluative judgment immediately. Therefore, it can be assumed that the evaluative state, that later leads to the formation of attitude towards mathemaitcs, emerges more distinctly after primary school education when mathematics, in school curriculum, moves from simple and concrete calculations more towards the abstract mathematical ideas. On parallel, a "need of cognitive structure" is also essential part in this formation of attitude. Student after the age of 10-11 years, at early adolescence (cf. Piaget theory[6], 1983),

[6] The theory of Piaget regarding the cognitive development stages, student moves from concrete operational stage to preoperational stage where abstract reasoning is to be developed leading through concrete thinking.

develops beliefs about his capabilities and competencies while experiencing the abstract understanding in mathematics. Outside the classroom, these self-perception beliefs passing through certain social influences attain certain level of intensity. At this stage, the formation of mathematics attitude refines “directly or vicariously” more and the probability to think evaluative about the utility of mathematics and judgment of pleasure in learning thence increase. This formation process of attitude towards mathematics is explained in various ways that are linked with different concepts of attitudes, already have been explained in previous chapter. Our aim, here, is to study how different factors like, parents, teacher and students’ own characteristics communicate their effect in order to construct the knowledge. Moreover, which particular dimension of this constructed knowledge is more responsible for the formation of attitude towards learning mathematics that further influence already developed attitudes with the course of time? In the light of this insight of research literature, next aim of this chapter is to propose a theoretical model of formation of attitude towards mathematics.

2.2 Factors involved in the formation of attitudes towards mathematics

Mathematics attitude formation is rather a complex phenomenon. Individuals develop their perceptions, about mathematics and its importance, based on the relation with other objects in the light of their personal experiences with it. Further, the degree of attachment what they have with this discipline is attained in the presence of influencing factors. This process of development of perceptions, communicates with individual’s general (gender, socio-economic status, etc.) and specific characteristics (intelligence, aptitude, self-confidence etc.) under the influence of social and cultural factors and their inter-relationships. This process of communication, in results, develops individual’s mathematics specific attributes. These mathematics specific attributes like, mathematics self-efficacy and self-concept etc., help him to evaluate his mathematics perceptions to generate mathematics belief and interest that leads to form attitudes towards learning of mathematics. Therefore, such contributing factors can broadly be divided into two main groups; one is environmental based or set of external factors and other are learner-based variables. Environmental based or external factors include all factors that exist around the individual and have direct or indirect relation with him. For a child, external factors broadly distinguish as ‘in-home’ and ‘out-of-home’ factors. Parents are significant element of ‘in-home’ category, whilst, teacher is a major contributing element among other units of society in the ‘out-of-home’ category.

The other unit, that is, individual’s or learner based factors deals with confidence, aptitude, self-beliefs etc. Here, in our research, we are limited to the role of parents and teachers related factors as the main ingredients that are responsible in developing child’s beliefs and interest in mathematics and his own self-perception beliefs in the formation of mathematics attitudes. Whilst, cultural norms, mathematics and gender specific stereotypes, and social milieu develop a system through which all units of society develop and communicate their thought. Therefore, this study is aimed to explore the scholarship of research to discover what and how learner based variables & external factors operate to develop attitudes towards learning of mathematics. First, research will be reviewed on external factors and then learner-based variables will be examined.

2.3 Parent’s Influence

Among the salient factors, parents’ influence is considered to be the most primary source for the development of interest in education among the adolescents. Especially, in case of attitudes towards mathematics, parents’ involvement, physically or financially, often creates positive outcomes for their children of all ages. Alles-Jardel (1995) remarked that family environment has a great effect on the formation of attitudes of children, especially, parents’ level of education. In family environment, particularly father’s professional status or mother’s profession (specifically in case of girls’ education) influence more children’s learning in mathematics and science and later in the choice of subject-specialization.

Parents’ own belief about mathematics, on the one side, affects the beliefs of children about mathematics, and on the other side, through their feedback they exert a substantial influence on children’ own perception about their capabilities in learning this discipline. Musun-Miller & Blevins-Knabe (1998) quoted that,

> If parents and non-parents differ in their views concerning the importance of mathematics and how it is learned, it suggests that these attitudes are connected to the role of parent and experiences of parenting (p.193).

A number of studies (Hoover-Dempsey & Sandler, 1997; Eccles et al., 2007; Turner & Brissett, 2010) affirmed that parent’s expectation and interest in the educational process of their children has a strong correlation with their learning and success in school. McGrath & Repetti (2000) found that students' (both boys and girls) own perceptions about their educational competencies enhance and are highly predictive from their parents' level of satisfaction about their performance. Such results provoke the need to understand the phenomenon that how parents transfer their perception about mathematics to their children. Further, it is pertinent to study that what expectations students themselves perceive which their parents hold for their abilities to learn and their success in mathematics.

In the present study, the parental role in the formation of children's attitudes towards mathematics is explored in three major axis, these are: socio-economic status and help, motivation and expectation, and their gender-specific beliefs about the learning capacities of children.

2.3.1 Role of parent's socio-economic status and their help

Socio-economic status (SES) of parents is the basic and important factor that sets the direction for, and contributes to the quality of, educational life of a child. SES is most commonly used term in education research and is often defined as the combination of certain variables. In research, a wide variety of variables can be found in the form of combinations used as the indicators of this term (White, 1972). Among them, the most utilized combination is based on the variables of family income, parents' education level and their occupation. Some authors added "family size" and "ethnicity" along with. Chapin (1928) defined the term SES as:

> The position that an individual or family occupies with reference to the prevailing average of standards of cultural possessions, effective income, material possessions, and participation in group activity in the community all relates to socio economic status (p.99).

Another way to look SES is presented by Mueller & Parcel (1981). According to them, SES describes an individual's or a family ranking on a hierarchy according to access to or control over some combination of valued commodities such as wealth, power, and social status (as cited in Sirin, 2005, p.418).

SES, therefore, can be a significant variable in terms of providing children's better educational facilities and opportunities to lead a better life. In schools, it has a vital role in learning mathematics. A profound scholarship of research studies affirmed the positive correlation between parents' SES and child's academic achievements (Bond, 1981; Coleman, 1988; Sirin, 2005; White, 1982). While, in Meta analyses of the studies done in this cadre; White conducted from 1918 to 1975 and Sirin conducted from 1990 to 2000, it was revealed that SES and school achievement were positively correlated variables with correlation magnitude of M=0.343 and M= 0.299 respectively. But this relation was not found quite linear in research as it is linked with other multiple variables that affect this relation indirectly, like: ethnicity, neighbourhood location, family size etc. Furthermore, research pool on achievement and attitude relation concludes that achievements and attitudes are also positively correlated variables. Though, few researchers (for example, Sjöberg, 1985; Warburton et al., 1983) argued that achievement predicts interest and attitude more directly and strongly, nonetheless, a great deal of research (for example, Aiken, 1970; Hammouri, 2004; Reynolds & Walberg, 1992; Tayyaba, 2010) confirms this relationship mostly interdependent and implicit. Apart of the discussion of interdependencies of variables, if these two main conclusions of research are compared, then it can be said that high SES plays a crucial role in developing positive attitudes towards mathematics and in achieving better scores in it. The reason is also evident, as the parents from middle class and high socio-economic class possess enough financial resources to arrange quality education for their children by sending them in reputed and quality institutes. Further, with better SES, thay can provide them with extra individual private coaching of mathematics as compare to those with low SES. Therefore, income or financial resources can also be the significant and potential indicator of SES to bring child to have better understanding in mathematics and high achievements.

Parents and adults see themselves as major contributors in children's mathematical learning than teachers do especially for pre-school children. This may be true because, if parents are able (financially or educationally) to provide their children an assistance in mathematics homework, they themselves function as a significant bridge in their children's proximal development (cf. concept of Zone of Proximal development, by Lev Vygotsky, 1978) that fasten their cognitive development process to reach at their expected cognitive level. Therefore, regarding the role of parents' education in SES, it is observed that educated parents help their children in a better way in their learning process. The children of educated and professional parents have high probability of continuing higher education especially proceed in high earning careers (Cuff, 1933; Kaeley, 1990; Tuppen, 1981).

Parents’ help, in the form of homework assistance or in the form of activities to develop the mathematical skills, depends on many constraints. These constraints that may, in other way, defines the “opportunity structure” (Jacob et al., 2005) are financial resources of parents, educational level and specialization, availability, family size and gender specific beliefs. Between parents, mother’s role is found highly important especially in developing child’s early beliefs about learning mathematics and mathematical conceptual development. In a study, Bacon & Ichikawa (1988) revealed that mothers, belonging either to middle or working class, reported teaching their children *numbers/counting* before sending them to school for their formal education. This significant effort of mothers later enhances interest in *numbers* activities and thence develops conceptual knowledge of mathematics (Griffin et al. 1994; Miller & Knabe, 1998; Saxe et al. 1987). Therefore, keeping this fact in view, the role of mothers who have no education at all may leave discrepancies in the development of early beliefs about mathematics and learning of mathematics at the part of children.

Studies reveal that father’s education and his occupation has significant positive relation with the student’s achievements and career aspirations. Father’s education is seemed a better predictor of mathematics achievement than mother’s education (Tuppen, 1981 in Kaeley). Chopra (1967) evaluated the effect of father’s occupation as a strong indicator of students’ achievements than income, and concluded that the children of professional fathers do significantly better in mathematics than those whose fathers earn high income.

In addition to parents’ SES, their involvement in the child’s educational process depends on their own feelings about mathematics. Gisberg et al. (1992) argued that the parents’ own feelings and experiences in mathematics on which academic socialization of children is based, is more influential than the variability between the educational achievement and feelings of students alone. In a research, Musun-Miller & Blevins-Knabe (1998) confirmed the effect of parents’ perception about their children on the children’s own engagement in mathematics. They argued that parents from different socio-economic status who place more importance to mathematics, they engage in mathematics activities more frequently in helping their children.

Above-mentioned fact reveals that such help or assistance of parents may be influenced strongly by their own beliefs and expectation of their children's performance in mathematics. Neuenshwander et al., (2007) reviewed different studies and remarked that parents' SES has positive correlation with their expectations for their children's abilities, achievements and self-concepts. They further concluded that parents' education expectancy from their children in mathematics, influence their academic ability self-concept. More they expect from their children, more their children gain confidence in their abilities. This concomittent relation encouarages them and enhances their motivation towards learning mathematics. Therefore, to gain more insight on the role of parents' encouragement in the formation of mathematics attitude, following is given the reflection of research on this aspect.

2.3.2 Influence of Parents' expectation

Research on parents' influence on children's mathematics attitudes and achievements have studied the role of parents' expectation in terms of positive feedback on the children's learning in mathematics and found it as of crucial importance (Armstrong & Price, 1982; Casserly, 1980; Eccles Parson et al., 1985; Fennema, 1977; Poffenberger & Nortan, 1959). In most of these investigations (Eccles, Jacob et al., 1986; Eccles Parson et al., 1985; Visser, 1987), it was revealed that parents possess different expectations from their sons than their daughters and encourage them accordingly. Such expectations affect children's own perception about their ability in mathematics, specifically at early adolescence and choices of their career later. Visser (1987) studied the relationship between parents' attitudes and expectation of child's mathematics achievement with his achievement behavior. He showed that both mothers and fathers consider mathematics as important subject more for their sons than their daughters. In consequence, regarding students' perception about their parents' expectation towards them, boys of both 7^{th} and 9^{th} grades perceived significantly more expectation than girls. It seems that this process is concomitant as both parents' and children's beliefs influence each other's beliefs and expectations.

How gender-differentiated perceptions of parents form and affect their expectation? Further, what perception children gain about this expectation is indeed complementary to study (cf. Jacobs et al. 2005). As Miller (1995) remarked that parents' expectations that usually develops from the early schooling years "*once set don't change much after in later years*".

Therefore, in order to understand the development of such expectations of parents regarding children's capacities to learn, it is worthwhile to study what beliefs they possess regarding gender segregation in careers. In the following part, review of research is presented in the cadre of parents' beliefs about gender segregation and its effect on their attitudes towards children's mathematical capacities.

2.3.3 Parent's belief about gender segregation in mathematics or related careers

In spite of achieving social and technical modernity, traditional gender segregation still can be observed in homes in the form of parents' beliefs about their children's capacities to learn and excel. In general, parents expect their sons to do better in mathematics even though they don't observe any ability difference between their sons and daughters. Eccles et al. (1983), in their work on model of parents' socialization, showed that both fathers and mothers are gender stereotyped about their children's abilities in learning mathematics. Parents, generally, rate their sons' success in mathematics as "natural talent", while, daughters' success as a result of their "effort". Such expectations of parents (sometimes are different as a mother and as a father) towards their children's mathematical ability are influenced by their gender specific beliefs about mathematics. As Miller & Knabe (1998) mentioned, that,

> Our culture's tendency to view science and mathematics as male domains, adults' gender could be connected to the importance they place on mathematics for young children […], in general, men could possibly see mathematics being more important for young children than women do (p.193).

How and from where such gender specific beliefs based on gender roles penetrate in parents' perceptions? The obvious reply is the cultural values and social milieu that describe roles of each group, sometimes based on status quo, race & ethnicity, and sometimes based on gender that are underpinned several respective stereotypes (Ambady et al., 2004). Bornholt (2000) remarked that "gender stereotyping is a distribution of reality that describes how adolescent see their competence is gender-marked content domains – at odds with actual performance" (p.353).

Such gender-marked content domains at initial levels are introduced to child from very early years at home in the form of toys and games provided by parents. Parents' gender specific beliefs define social-emotional environment of home where child is reared up with certain gender-specific social values through which stereotypic beliefs transfer to them. Therefore, it is evident that parents' own belief in gender roles influence children's own perception about their mathematical capabilities. Children when they perceive parents' attitudes towards them, they themselves see their abilities through *gender-polarizing lens* and develop mathematical self-concept, directly related to their parents' perception and consistent with traditional gender stereotypes (Neuenshwander et al., 2007).

The roots of such traditional gender segregation, on the other hand, embedded into the division and nature of work too. Since from past, men were to hunt, bring food, made weapons and tools whereas women were to serve husbands, cook food and childbearing and rearing. Even in modern society, only the mode of work is changed but in some cases, the specialization and division of labour are still seen in similar way as it were in past. Gender segregation based on stereotypes; *men are strong and intelligent*, and *women are fragile and emotional*, is still stable. That is why, technology and scientific fields are still considered as male occupations, while, Arts, language, designing etc., are seen as female occupations. This belief can be observed even in school subjects. Subjects those leads to these respective professions are divided into masculine and feminine, e.g., mathematics is a male domain, is a well-known stereotype.

To this end, after exploring the scholarship of research on parent's role in the development of children's mathematics self-beliefs and their attitudes towards learning mathematics, in following part, significant factor of "out-of-home", that is teacher's influence on students' mathematical competencies is discussed.

2.4 Influence of Mathematics Teacher

Teacher is the major factor of "out-of-home" section on the nexus of social influence in the formation of mathematics attitude. Teacher plays an important role in the development of student's perception about their mathematical abilities. These perceptions of students that they perceive from "out-of-home" social agent (teacher) are directly linked to the teacher's encouragement for, and behavior towards, students in the classroom. In addition, a great deal of research has addressed the issue of achievements and learning in mathematics in relation with teachers' pedagogical skills to teach mathematics. Nonetheless, little work has addressed the issue of the influence of students' perception of teachers' perception and expectations of them, that is, how students perceive their mathematics teachers' attitudes, methodology and expectation towards them and develop their self-concept in mathematics in return (Philippou & Cristou, 1998; Tiedmann, 2000). Furhter, whether perceptions about teachers' perception, classroom environment effect or form their attitudes towards learning mathematics? Moreover, how these perceptions and attitudes of students, once developed, effect their decision of evasion or adoption of mathematics later in higher education stage and career choice? These issues are to be explored in order to deal with the low achievements and low participation rate of students in mathematical sciences. As Xin Ma (2001) argued that, "individual development cannot be adequately examined without considering significant social influences that either hinder or enhance individual change" (p.133). Therefore, teachers' influence which filters through societal constraints is a point that needs to be focused in responding the question of "how" students' perceptions about teachers' behaviour reveal students' conception about mathematics. Here, in this chapter, this issue is explored in two tiers. Firstly, teachers' own self-beliefs, pedagogical skills beliefs, and their own attitudes towards mathematics. Secondly, the role of teachers' beliefs about students' abilities, interaction and behaviour towards them, is examined in the formation of students' beliefs and interest in mathematics.

2.4.1 Teacher's mathematics self-beliefs

Teachers are believed to be the torchbearer in any society. In the classroom, mathematics teachers (MT) deliver not only the content knowledge effectively to the students but also are the source of transferring the societal and cultural beliefs, norms, and values to the students. Thus, on the one hand, their knowledge about subject matter, their pedagogical skills and strong assessment, and evaluation process play a determinant role in equipping the students with the mathematics knowledge. On the other hand, their beliefs, ideologies and personalities bring profound effect on the students' conception about their own learning abilities in mathematics and perpetuate with analytical mode of thinking and beliefs. Therefore, this aspect of Mathematics teacher's factor is examined into two main dimensions; first is related to subjet-matter pedagogical beliefs, and second addresses the influence of teacher's gender and his own attitudes towards teaching mathematics.

Mathematics Teacher's subject-matter pedagogical beliefs

Mathematics teacher (MT), in the class, encounters with students coming from different social backgrounds, with different level of mathematical competencies and varied prior content knowledge. The great quality of a good MT is to bring all students together along with their individual differences towards the successful conception of the topic. Teachers' beliefs, their content knowledge in mathematics, clarity of perceptual & structural aspects of mathematics, and decisions in its delivery depict that how a teacher perceives mathematics. This perception of MT is directly linked with the students' achievements and learning capacities (Peterson et al. 1989). An example of this fact can be observed in the research conducted on the theory of cognitive acceleration in science and mathematics education in previous two decades of 80's and 90's (cf. Shayer & Adey[7], 2002). In these studies, teachers were trained for cognitive skilled pedagogy in the professional development programs to see its effect on students' efficiency in resolving the mathematical problems. In result, the residualized gain scores in post-tests confirmed the enhancement in the cognition and quality of thinking skills of students for solving the mathematical problems (Abbas, 2007).

It is evident that research on assessment of teachers training programs emphasizes on the use of pedagogical techniques and effectiveness in teaching of mathematics but the subject-matter and depth of *pedagogical content knowledge* that teachers possess mainly were not focused. Such situation was referred to "missing paradigm" with respect to the research on mathematics teaching. Teachers' pedagogical content knowledge term was introduced by Shulman (1986, p.9), as an important category of teacher's cognition related to thought and behavior. According to the researcher, it is,

> The ways of representing and formulating the subject that make it comprehensible to others ... an understanding of what makes the learning of specific topics easier or difficult: The conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons (as cited in Peterson et al., 1989).

[7] A series of cognitive intervention projects were launched to accelerate the cognitive thinking skills of the students from year 5 to 15, lead by King's College of London.

Here, one thing must be cleared that pedagogical content knowledge is bound with content knowledge and is different from the general pedagogical knowledge and “straight” content knowledge (Schoenfeld, 2005).

Vast conceptual knowledge with enriched didactical representation based on cognitive approach enhances the cognition of the students to grasp the concept from bottom to top. Few researchers have attempted to analyze that how teachers’ beliefs within a specific topic area or domain of mathematics with respect to some particular grade level affect the quality of leaning of students in mathematics. One such research conducted by Peterson et al., (1989) on the analysis of teachers’ beliefs about pedagogical content of addition and subtraction concept at first grade level in school, and further, how it influences students’ learning and achievement. They assessed pedagogical content knowledge of 39 mathematics teachers in relative problem difficulty, general knowledge of strategies and knowledge of pedagogical content. Two main groups of teachers, differ in beliefs corresponded to cognitively based perspectives, were found namely; teachers with beliefs more cognitive based (CB), and teachers with beliefs less cognitive based (LCB). Results demonstrated that students’ achievements were positively correlated with teachers’ beliefs. Further, students of CB teachers scored significantly higher (at $t = 1.81$) than the students of LCB teachers in both problem solving test and number-fact knowledge (a computation test). They commented that, teachers’ beliefs (CB and LCB) effect their selection, organization and presentation of mathematics content, and their pedagogical strategies. These in turn, influence the nature and quality of students’ learning and achievements (cf. *The wisdom of Practice* by Lee Schulman, 2004).

Mathematics teachers’ gender, self-concept and attitudes towards teaching Mathematics

A great deal of research addressed the issues of attitudes and achievements of the students in relation with teacher’s self-concept and attitude towards mathematics (Atweh et al., 1998; Duru-Bellat & Zanten, 1997; Duru-Bellat, 1994; Fennema, 1996 & 1981; Li, 1999 & 2004). These variables of MT closely related to the teacher’s gender, which play a crucial role in framing students’ perceptions about their competencies in mathematics according to their own gender. Teachers should continue education process with gender-free influence and they themselves too, were reported to believe in liberty and democratic environment in classrooms (Skolnick et al., 1982). However, in real situation, teachers are observed to impart traditional behavior and beliefs of gender segregation regarding future career plans for boys and girls irrespective of student’s interest and aptitude (Li, 1999 & 2004). This influence can be observed even more strongly in traditional societies. While, studying the relationship between the gender of the teacher and its effect on the students’ achievements, Warwick & Jatoi (1994) found that as compare to students’ gender, teachers’ gender in Pakistani society has strong effect on students’ achievements in mathematics, especially in rural areas. In case of students’ attitudes towards mathematics, research reported a significant difference between the students of male teachers and female teachers. Girls taught by female teachers and especially in single-sex schools, were reported to have positive and gender-free attitudes towards mathematics as compare to boys taught by male teachers. This fact is reported by other studies too carried in other parts of the world (Atweh et al., 1998; Duru-Bellat & Zanten, 1997; Duru-Bellat, 1994; Fennema, 1996; Lee & Lockheed, 1990; Mosconi, 2005 & 1994). Thus, teacher’s gender may be seen as a significant factor in defining his self-concept and stereotypic belief in transmitting the gender-biased beliefs about mathematics in students too.

The effect of the mathematics teacher cannot be comprehended completely unless we observe teachers’ own mathematical self-concepts, their level of consciousness of beliefs and attitudes towards mathematics (Ashton and Webb, 1986; Lester, et al., 1989; Pehkonen, 1994). As not every teacher who teaches mathematics has the same motive to adopt this profession, thus, may vary in her or his affiliation with teaching of this discipline. Therefore, MT’s self-concepts and attitudes are to be studied too, along with students’ attitudes and mathematics self-beliefs because, they, as a source of transferring their own mathematics attitudes, imparts mathematical content knowledge. Relich (1996) remarked that “Is it possible that we may be producing teachers who lack confidence in their own abilities as problem solvers and as mathematicians?”(p.181).

Researchers (Blundun & De La Rue, 1990; Gibson & Dempo, 1984; Perry, Ngai–Ying, & Howard, 2006; Philippou & Christou, 1998) identified that teachers with high self-concepts and positive attitudes towards teaching mathematics ususally engage in creative practices that confirms that students’ high achievements gain. Whereas, students of teachers with low mathematics efficacy achieve low grades in mathematics (Chester &

Beaudin, 1996; Relich, 1996). Relich (1996) studied mathematics teachers' self-concept and its effect on their teaching approaches. He demonstrated that teachers' own early experiences with mathematics particularly in primary schools and their parental attitudes were two strong influential agents in the formation of their self-concepts. Researcher identified that "*traumatic experiences*, usually in the upper primary grades, could potentially have a life-long impact on *self-concept*" (p.191). Relich found that mathematics teachers with high self-concept were more positive about the value of in-service, in-school sessions and co-operative efforts in teaching of mathematics. Thus, in the classroom, it can be said that teacher with high self-concept in mathematics is motivated to implement creative ideas in order to develop mathematics relevance. While, teacher with low mathematics self-concept is more likely to complain about lack of time and resources, lacks in love and appreciation for mathematics, and adopts limited creativity of mathematics during the lesson. Further, in comparing primary and secondary school MTs, researcher found that mostly primary school teachers were having significantly low self-concept than secondary school teachers and among them more female teachers than males were reported low self-concept in mathematics. But at secondary level no such difference was found significant. It seems that early mathematics experiences of students with mathematics teachers at primary level affect students' self-concept and motivation to learn this discipline later at high school level. And as female mathematics teachers at primary level were observed to have low self-concepts, then these "female teachers would present inappropriate role models for their students, especially their female students" (p.181).

Hence, a cyclic process can be assumed, that is, future or in-service teachers who could not have a chance to develop positive self-concepts and attitude in mathematics, they impart such sentiments unconsciously to their students which further cause the low self-concept and enthusiasm in mathematics (Abbas, 2007; Sang, 2010). Here, a question arises on the efficacy of teachers' training programs also, that is; are such trainings not enough effective to remove the impact of previous mathematics experiences and develop high mathematics self-concepts among the young mathematics teachers? As mentioned by Philoppou & Cristou (1998) that most of the teachers training programs do not take into account the attitudes and beliefs of candidate teachers towards mathematics.

To enhance the positive attitudes among the future mathematics teachers, Philoppou & Cristou (1998) introduced a preparatory program for three years based on historical development of basic mathematical concepts and the mathematics content course. Results of this study affirmed that more than two third of the future mathematics teachers at entrance level in teachers' training program were having the negative attitudes and low efficacy in mathematics. In the end of the preparatory program, a significant positive change was observed among all trainee teachers in their attitudes and problem solving confidence in mathematics. An interesting fact was observed in this research that, those trainee teachers who disliked mathematics, among them 39% (the highest percentage among all the reasons for disliking mathematics) had given the reason that it was because of lack of teacher's enthusiasm whereas, 33% referred towards their fear. Results indicate the dominating role of teachers in developing any kind of attitude of students towards mathematics. Above-mentioned studies revealed that a considerable proportion of mathematics teachers has negative attitudes towards mathematics and sees less relevance with practical life. Such teachers, when they teach, fail to attract their students' interest towards learning of mathematics thus cause formation of negative attitudes among students towards mathematics in later years.

2.4.2 Teacher's encouragement and students' attitudes towards mathematics

The effect of teacher's content knowledge beliefs, his own mathematics attitude, and pedagogical skills were studied in accordance with students' performance and their attitude towards mathematics. It is concluded that, teacher's beliefs about students' abilities may vary according to the gender preferences. It is widely argued that teachers' behavior in the classroom is not neutral to both sexes. In addition, mostly (not all) researchers (Cahill & Adams, 1997; Calvanese, 2007; Ernest, 1976 & 2004; Gates, 2006; Gray & Leith, 2004; Ifegbesan, 2010; Jones et al., 2000; Tatar & Emmanuel, 2001; Tiendmann, 2002) affirmed teachers' biased attitude in the class. Regarding the degree of such influence of teacher in the presence of other numerous factors, including home, researchers studied the role of teacher's belief and expectation in the development of students' beliefs on their own mathematical abilities. Stephan (1967) studied the proportional effect of home and school factors on the learning capacities of the student in mathematics. He found that students' own abilities, experiences, and pressure that exerted from homes and community, mostly bring students towards learning. Whereas, teacher affects student's capacity regarding educational outcomes indirectly. Centra & Potter (1980), in addition, presented this conception in this way: "learning is something children do (at times in schools), not something which schools or teachers do to them" (p.287).

The other point of view that can be found in research is that, teacher's behavior plays such an immense role in formation of attitudes of students towards learning mathematics, and their perceptions about their self abilities regarding achievements, that the effect of other variables reduces or diminishes (AAUW, 1992; Gray & Leith, 2004; Kessels & Taconis, 2011). Further, such behaviors not only affect students' performance but their beliefs and esteems about their learning abilities are influenced too. Although, both points of view are at extreme positions at their poles, however, both contain certain chunks of truth. The time spent by the students with teachers, if compared with the combined effect of all other factors, may not be more than one third part of the day and night. Whereas, rest of the time they spend under the influence of their communities and homes where including socio-economic status (SES) and other factors like, religion, society, etc. contribute to the development of their perception to a great extend. However, later conception of teachers' behavior influence can be justified in this sense, that, teachers too, are society members, their beliefs are constrained by the culture, education system and traditions of the society (Perry et al., 2006) thus they can be the source of bringing these effects in the classroom. As Peter Gates (2006) pointed out that, "As social beings, mathematics teachers do not come to classroom devoid of social and political motives and intentions" (p.351).

One or other, although pointed out less frequently in research, for us these are equally true. Both theses are to see an object from two different angles, which do nothing but to promote more the role of teachers' behavior on students' personalities and performances, as both points of view do not deny teachers' influence.

Teacher's encouragement basically reflects his expectations from students, which are influenced by many factors, most influential are the student's gender, his socio-economic status, past achievements etc. Here, this chapter discussed the influence of teacher's encouragement is discussed in the light of her or his expectations about the student's mathematical ability and performance with respect to his gender. There are mixed results documented in research regarding teachers' encouragement to their students to perform based on their gender. A large pool of research (for example, Bergan & Smith, 1966; Duesk & Joseph, 1983; Kehle et al., 1974) affirms the fact that teachers expect good performance from students during elementary school years. However, few researchers (Bar-Tal & Saxe, 1979, Ma, 2001; Purgess, 1979) also reported no significant difference in teachers' expectations from students academic performances based on their gender. Apart of differences in conclusions of these studies regarding gender based difference, it is a considerable assumption that teacher's perceptions about boys and girls as the learners of mathematics, his expectations from a boy and a girl, and further, his behavior towards them, prepare boys and girls differently to recognize their role as a societal members.

Teachers' beliefs and their expectations that are filtered through the societal constraints may have particular perception about gender and stance on the roles of gender. Tiedmann (2000) analyzed social stereotypical effect on the mathematics teachers' beliefs about the students' competencies in mathematics and its effect on the students' achievements. In this study, in which 52 elementary school mathematics teachers and 312 students from 3rd and 4th grades were participated, researcher concluded no significant gender differences in mathematics performances. Nonetheless, results regarding teachers' beliefs about the competencies of students showed high stereotypical biased perceptions for boys and girls. Teachers' beliefs about mathematical competencies of students revealed that teachers believe that mathematics is more difficult for girls than boys and further boys (even showing average performance) are more competent in their logical thinking while doing mathematics as compare to girls. Regarding attribution of performance, teachers had perception that little or extra effort contributes more for boys to achieve level of actual performance than girls. Further, concerning the cause of failure in mathematics, teachers remarked lack of ability as a cause for girls while for boys it was lack of effort. Students' self related beliefs when inquired by teachers, they reported more girls than boys were having low self-concept and confidence in their mathematical abilities. More or less, similar findings were reported by number of other researchers (for example: Blondin & Lafontaine, 2005; Brophy & Good, 1974; Eccles et al., 1983; Ernest, 1976 & 2004; Gates, 2006; Parsons et al., 1982a).

Believing that girls have less capability to comprehend mathematics than boys, may affect teachers' encouragement through grading behavior in class. The information about the student's sex and ability level exacerbate teacher's subjectivity. To study this fact, Duval (1980) conducted an experimental research on 297 secondary school students and 102 secondary mathematics teachers. Teachers were asked to grade the students according to presumed abilities. In next session, students' abilities in geometry were analyzed in three levels. Results indicated that on contrary to the actual level of abilities, teachers graded boys, both in above and below-average ability groups, higher than the girls.

Such expectations based on specific beliefs triggered into respective behaviors towards students. Mathematics teacher's positive expectations that result in his encouragement motivate students towards learning mathematics and high achievement aspirations. Harris & Rosenthal (1985), remarked that,

> Teachers, who hold positive expectations for a given student will tend to display a warmer socioemotional climate, express a more positive use of feedback, provide more input in terms of the amount and difficulty of material that is taught, and increase the amount of student output by supplying more response opportunities and interacting more frequently with the student (p.377).

Though mathematics teacher's encouragment play an important role in developing student's own perception about his mathematical abilities in elementary school years but with respect to age factor, its effect reduces as individual matures in his cognitive and affective characteristics. Ma (2001) studied the influence patterns of teacher's expectation on the students' participation in advance mathematics courses from ninth to twelfth grade. In the light of the results, he concluded that students' high socio-economic status and previous achievements in mathematics are significant factors that influence teachers' expectations for students to enroll in advance mathematics courses. He documented that effect of teacher's expectation declined with the course of time as students move in higher grades. Though, teacher's expectation remains necessary component and a significant factor till secondary school, but at advance level, it's direct effect on students was lessen as a significant influencer for continuing mathematics. Besides at advance levels, students' positive attitudes, their previous mathematics achievements and high career aspirations play more significant role in order to continue this discipline than teachers' expectations.

2.4.3 Teacher-student interaction and classroom environment

Another contributing factor of the classroom social environment is teacher-student interaction. During this social relationship, teacher's preference helps certain students in emotional adjustment in the classroom. Teacher-student interaction in the classroom settings is an indicator to observe and analyze the teacher's expectations from and her or his encouragement to students. Therefore, the role of teacher-student interaction in the classroom environment is of paramount concern for the researchers in order to explore the effectiveness of learning process. Research, in this cadre, was focused on the frequency of interaction, that is, how many times teacher asked question and addressed the students during lecture, and which student in the class was interrogated for the concept. Moreover, in gender related studies this problem was addressed to determine the role of teacher's interaction in developing the students' motivation towards learning based on gender preferences. Here, the research discussion is focused on later issue, that is, to examine how differently this socializing process effect students' active participation in class.

Research on teachers-student interaction reveals that mostly the interaction patterns were gender biased that disfavor female students. Sadker & Sadker (1994) studied that teachers of elementary and middle schools tends to initiate more communication with boys as compare to girls. In their observations, they reported that the ratio of boys to girls that called out answers was eight to one and further, teachers listened carefully to them in response. Even when boys interrupted during the lesson, teachers allowed them to do but in the case of girls, teachers expected them to be self-controlled and to raise their hands before they speak, which leads them to think that what they say or think does not matter. In addition, teachers interact with boys more intellectually and give them detailed instructions during a project or an assignment as compare to girls, which may lessen the interest of girls in mathematics. Insights of these research investigations clearly demonstrate gender biasness in teacher's interaction, which may be rooted in the traditional stereotypes. These traditional stereotypes affect teacher's personal beliefs of boys more active and intelligent than girls are rooted in traditional stereotypes. Jungwirth (2002) in discourse analyses of the teacher's interaction remarked that,

> As a result of my investigation of interaction in the mathematics classroom, successful — in the sense of corresponding with the teacher's actions — participation in the classroom discourse as it usually goes has become a routine

> more for boys than for girls. Boy-teacher interactions tend to run smoother than girl-teacher interactions — not always, but if there is a mismatch in the academic interaction then it is with girls. Consequently, with boys more mathematical competence is established (p.64).

Similar findings of teachers' biased interaction are reported in many studies highlighting different angles, for example; boys' more willingness to answer in the class than girls, boys raise their hands more often (Brophy & Good, 1970; Sadker & Sadker, 1994), teachers' attention divert more towards boys, more hugs, arguing because of their aggressiveness (Cherry, 1975; Ebbeck, 1984; O'Leary et al., 1973; Serbin & O'Leary, 1975), teachers give more social-personal remarks to girls in the class (Honig & Wittmer, 1982), etc. These results clearly affirm the effect of social & cultural distinction of gender based on capabilities and courage. As Susan & Chipman (2002) remarked that "boys tend to handle the "*rules of the game*" better than girls, which means that they conform more easily to the teacher's expectations, which are, of course, geared to this style of instruction" (p.188).

In addition, research indicates that tendency of teacher-student interaction ratio differs with respect to the age (Chipman & Wilson, 1985; Koehler, 1990; Leder, 1990b; Susan & Chipman, 2002; Toale, 1995). Gender biased interaction in the class usually reported after the early grades of primary school. For example, Morse & Handly (1985) studied gender differences in science class interaction. They found that girls, as they move in upper grades, less interact with their teachers; girl-teacher interaction, that was 41% in seventh grade, was reduced to 30% as they moved in eighth grade. Whilst, the case is opposite for boys; boy-teacher interaction was raised from 57% to 70% as they promoted to eighth grade. This trend continues at upper grade too. Researchers (Kruprick, 1985; Sadker & Sadker, 1986; Wingate, 1986) documented a considerable decrease in girl-teacher interaction in post secondary and college levels, whereas for boys, an inverse case was observed. On the other hand, research on teacher-student interaction reported the same patterns. Researchers found that teachers interact more with male students than female students, even if students (both boys and girls) are showing same level of high confidence and ability in mathematics (Bank et al., 1980; Brophy & Good, 1974; Reyes & Fennema, 1982). Such practices result in directing girls more towards passive behaviour in classroom activities and encourage boys to excel more in their self-confidence. Though, consequent outcomes do not confirm gender differences in mathematics achievement but clearly distinguish boys and girls on the base of their anxiety level and self-perception beliefs in mathematics in which gender differences usually appear after primary school.

2.4.4 Mathematics Teacher's behavior and motivation in the classroom

Research on successful learning and teaching process in classroom identified teachers' behavior along with interaction as the predominant factors among other influencing factors (Wubbels et al., 2004). Teacher's preference, an externalizing behavior (cf. Hughes et al., 1999), usually means the degree to which a teacher likes a specific student and indulges in interaction with her or him during the lesson (Chang et al., 2004; Mercer & DeRocier, 2008). A variety of other situational (like, motivation, classroom physical environment, etc.) and personality factors (like, attitudes and teachers' competency of content knowledge) have been identified as the moderators of teachers' behavior with students.

Fishbein & Ajzen (2008) proposed belief about certain action, which is an integral part of the attitude towards it, leads to externalize it in behavior. Whereas, motivation is an inner driving force that stimulates attitude and triggers in behavior (cf. theory of planned behavior, Fishbien, 1991). Researchers indicated that teachers' motivation towards their profession and working environment affect the students' success (Berelson & Sleiner, 1964; Hallinger & Murphy, 1985; Kandemir & Gür, 2009; Tracy, 2000;).

Teacher in the class teach mathematics by developing mathematical and analytical skills and bring students towards learning through her or his enthusiasm, motivation and positive attitude. These elements, all collectively, define the teacher's behavior. Fisher & Rickards (1998) demonstrated that students who perceive their teachers having leadership qualities and friendly or helping behaviors, had positive attitudes towards learning mathematics, and whereas, students who perceived dissatisfaction and strict behavior of the teacher, lowered in their intentions towards learning.

Student's motivation to learn mathematics enhances through the positive feedback that she or he receives from teacher. Mathematics teachers, who take care of students' psychological needs (like; listening patiently and acknowledge their point of views) and allow them to exert their mathematical potential during class activities, develop students' interest in mathematics. In a study on students motivation, while studying the effect of autonomy-supportive behavior of teachers, Radel et al. (2010) demonstrated that students who were taught by the teacher, practicing intrinsically motivated teaching style in the class, displayed high motivation in learning than the students of the control group. They further showed that this motivational effect transferred from student to student when they were exposed to peer tutoring session. These results provides the justification of above mentioned fact about teachers' own negative experiences in their school life that such behaviors (mostly negative or strict as their impact is more strong) of teachers transfer their negative feelings to next generation of teachers.

Therefore, students' perception about their mathematics teacher having coercive and strict behavior and deliver lessons without offering students time to diffuse their reflection, in fact detain them from initiations for learning (cf. Self Determination Theory; Deci & Ryon, 2002 for detailed discussion). Mainhar et al. (2010) investigated the association of teacher's behavior (coercive vs. supportive.) and the classroom social climate (students' perception of their teacher and peers were used as the classroom social climate indicators). They indicated that yelling in anger at students and punishing them during the lesson significantly associated with the lower teaching proximity (cf. Wubbels et al., 1985), that is, teacher's coercive behavior deteriorated the teacher-student relation in the class. Further, the effect of such disruption is not temporal but more influential than the positive effect of supportive behavior.

Researchers (Buhs & Ladd, 2001; Coie et al., 1990; Mercer & DeRosier, 2008; Taylor, 1989; Wentzel & Asher, 1995) identified that teachers' behavior ultimately affects the development of emotional adjustment, anxiety, self-efficacy beliefs and self-concept etc. in students. Research studies (Mercer & DeRosier, 2008; Pimta et al., 2009; Reddy et al., 2003) confirms that teacher's support, less externalizing behavior, less preferred interaction lowered student's anxiety and boast the self-efficacy. This supportive learning milieu enhances individual's confidence in learning and exploring mathematics that exert a positive effect on her or his mathematics attitudes and high achievements motives.

Above presented research literature, concerning parents' effect and teacher's influence indicated several aspects that provides the basis for gender differences as the result of boy's and girl's different perception about their abilities. Why parents and teacher differ in their dealings with students, this can be explored by examining their stereotypic beliefs. Therefore, next part addressed this issue and reviewed the research literature in this respect.

2.5 Stereotypes about mathematics competencies

A stereotype is a generalized belief, idea or image that a group of people have about the characteristics associated with the members of other social group. Walter Lippmann, a journalist, first popularized the term stereotype in 1922, which he described as the image that people have in their heads of what a social group is like (Encyclopedia of Social Psychology, p.939). In the domains of sociology and later in social psychology, stereotype was used as a term. Vinacke (1957) declared *stereotype* as a concept that has *fundamentally the same functions and general characteristics as other concepts*. Regarding the dynamics of stereotypes, Ashmore & Del Boca (1979) identified three conceptual approaches to explain it, i.e., psychodynamic, sociocultural and cognitive orientations. Psychodynamic is a motivational approach, which illustrates that a group leads to use certain beliefs in order to satisfy their important psychological benefits that provide them the feeling of superiority over other. Sociocultural approach emphasizes in the intergroups beliefs and attitudes that perpetuate through socialization experiences, learning and social reinforcement. Whereas, cognitive approach talks about the belief system or cognitive structure based on information processing that affects the perception about other group. Hamilton & Trolier (1986) defined stereotype in this context as a "cognitive structure that contains the perceiver's knowledge, beliefs, and expectations about a human group" (cited in Hamilton & Sherman, 1994, p.3).

Whatever the explanation of conceptual orientation of stereotypes, the main sources through which these stereotypes impart right from early years of childhood, and then transfer from generation to generation, are social agents. These social agents are the core identity of sociocultural approach, most importantly, parents, teachers, peers, and public media. Stereotypes exist right from early times in the society having basis in sex or gender, ethnicity & race, culture, socio-economic status & minorities, etc. Whatever the form of stereotypes is, these are used, on the one side, to justify the status quo that makes one group feel contented and justified in their hostile actions in which other group is affected. On the other side, affected group used to convince itself with such stereotypes and accept the disparities, inequalities and injustice that are present in the society(Hamilton & Sherman, 1994).

In the context of mathematics, a number of stereotypes exist and have been reported in research with respect to students’ ability and performance. These include: gender stereotypes, cultural stereotypes, minority & ethnicity stereotypes and socio-economic statue/social class stereotypes. Here in this study, mainly the gender stereotypes were focused about the students’ mathematical competencies, their problem solving abilities and their mathematics performances. Plante et al. (2009) cited gender stereotypes as the socially shared beliefs in which certain qualities can be assigned to individual based on her or his sex. Thus, gender stereotypes in mathematics are the mathematical ability beliefs, expectancy and perception of overestimation or underestimation of mathematical performance of people belonging to a particular sex, about the members of group of opposite sex.

A great deal of research indicates some traditional stereotypes about mathematics, like; mathematics is male domain, boys are more capable than girls in using mathematical strategies, etc. Albeit some recent studies seem to suggest that the intensity of such stereotypes is now diminishing with the better performance of girls in mathematics (Blanton et al., 2002; Martinot & Désert, 2007). One such research was conducted by Plante et al. (2009) to investigate the students’ perception about mathematics as masculine domain or feminine domain. Researchers conducted a survey on 1137 French-speaking Canadian students from grade 6 (11-12 years), 8 (13-14 years) and 10 (15-17 years) belonging to low socio-economic areas. Results of this study showed that boys of sixth grade significantly reported traditional stereotype about mathematics as a masculine domain. However, responses of boys of grade 8 and 10 were more neutral in the case of mathematics as male domain even more boys in grade 10 reported mathematics as feminine domain. Whereas, ratings of girls from sixth grade were representing mathematics significantly as female domain and this trend remained in favor of femaleness at grade 8 and 10 too. This study demonstrated that the degree of rating mathematics a male domain continued to decrease between grade 8 and 10 for both girls and boys but for the scale “mathematics is female domain” both boys’ and girls’ ratings were more in favor of. Similar findings were documented by other researchers too, for example; Rowley et al. (2007) for American students and Leder & Forgasz (2002) for Australian students. Researchers quoted possible reason for such change and unusual results is girls’ better achievements in mathematics for the past few years due to considerable encouragement of girls’ involvement in mathematics.

Above research is presenting rather a balance shape, nonetheless, a majority of researchers still is conforming the presence of gender stereotypes in mathematics and related careers in other parts of the world. For example, Chatard et al. (2007) analyzed stereotype beliefs in French students (average age = 15.5 years) and reported that boys believe to be more able than girls in mathematics. In the second part of this investigation, researchers remarked that in the result of these stereotypes, girls underestimate (researchers called it as "self-stereotyping") their performance, while, boys overestimate their scores even if there is no significant gender difference in their actual scores in mathematics. Similar results of ability-impugning stereotypes have been documented in the research by Good et al. (2008) and in other recent studies too (cf. Halpern et al., 2010). These investigations indicate presence of such stereotypic believes in society, which were imparted through parents and teachers and caused pernicious effects on females' mathematics competencies.

Gender role stereotyped differences that influence students' own perceptions about their abilities based on their gender. A major conception of these perceptions they absorb directly through practical and verbal interaction with their parents. Culturally prevailing representation of boy's mathematical and cognitive competence and girl's verbal and social characteristics also affect parents' expectations from their children accordingly. Such endorsement of gender biased expectation of mathematical intelligence from boys more than girls were reported in research.

Räty & Kasanen (2007) in a longitudinal study investigated parents' perception about children's gender stereotypes regarding mathematics competences & conceptions. Total 391 parents responded about their daughters' and sons' abilities in mathematics in grade three. Later, after two years same parents were interrogated about their assessment of children's mathematical competencies that were then in fifth grade. Researchers in the study found that parents' education and child gender had significant "effects on the endorsement of the stereotype pertaining to mathematics". Results indicated that vocationally educated parents demonstrated high stereotypic attitude in favor of boys than academically educated parents at the both grades. Among them, parents of boys mentioned significantly higher stereotypic attitude regarding boys' better competence than the parents of girls at the end of grade three. This perception of parents was lowered when students moved in fifth grade. Researchers concluded that parents are powerful source of endorsing their stereotypic views (such as, *mathematics is easy for boys because they are more intelligent than girls*) in children. These perceptions of parents are influenced by cultural expectations regarding gender that starts from early years of elementary school. Such assessments further guide parents' attitudes towards girls and boys differently, which consequently develop child's self-concept in mathematics (Eccles et al., 1990; McGrath & Repetti, 2000; Tiedemann, 2000).

Parents' perceptions and expectations for their children's abilities in mathematics are highly correlated with teachers' ratings of their children's competencies and performances (Eccles et al., 1990). Teacher is also a society member whose beliefs are embedded in the societal values and cultural constraints that educational system sustains through which they themselves passed and had experiences as student and then as an authoritative society member. Hence societal expectations and stereotypes affect teacher's perception of student's abilities and characteristics on the base of gender role. A rich scholarship of research proves that teacher possesses gender-biased beliefs about the competencies of the students. Boys in the class are believed to be more active, logical, quick in responding, using more cognitive strategies in solving mathematics problems and interact more with teachers than girls (Baudoux & Noircent, 1995; Bondain & Lafontaie, 2005; Duru-Bellat, 1990; Perry et al., 2006; Tiedmann, 2000). Even when girls outperform than boys, teachers rate this success to girls' more effort and in case of boys' superiority, it is always seemed as their intelligence. These beliefs direct teachers' expectancy degree, which affects their interaction and behavior with boys and girls in the class. Baudoux & Noircent (1995) studied the effect of stereotypic beliefs on the classroom culture. They concluded that girls don't receive fully their right of teachers' attention and teachers respond less to their individual questions as compare to boys. Such attitudes of teachers reinforce the stereotypes of docility of girls and aggression of boys that result into the development of their self-concept beliefs accordingly. As Mosconi (2005) remarked about the expectations from women that,

> Women should constitute their relationship to knowledge in the context of a society and sometimes in a family environment, where the belief in male superiority is still strong and where access to learned knowledge/academic

> knowledge is twicely/doubly forbidden because of the social origin and gender (p. 86)[8].

Research highlights that gender stereotypes in mathematics perpetuate through culture that affect members of one gender in negative way, while, other group observe positive influence in terms of high motivation and expectancy level (Eagly & Wood, 1991; Good et al., 2008; Fennema & Sherman, 1977). Therefore, when a person is in such situation in which negative stereotypes about the person or the group with whom she or he belongs to, could be applied to her or him and face the judgment based on such societal stereotypes, this situation is referred to as stereotype threat (Ambady et al., 2004; Quinn & Spencer, 2001; Spencer et al., 1999). Students' perceptions about mathematics as male or female domain affect their problem solving abilities and overall performance in mathematics. To study the research hypothesis that stereotype threat interferes with problem solving by impairing women's ability to formulate strategies, Quinn & Spencer (2001) conducted an experimental study. To explore that how such stereotype threat influences girls' ability to do mathematics, they administered two SAT-M[9] type tests (based on multiple choice word problems) with two conditions (reduced and high stereotype threat) at the students who obtained 670 or above scores in SAT. First test was conducted with high stereotype threat condition. Second test was conducted with reduced stereotype gender-fair condition, such that, *prior results of the test showed men and women performed equally well on these problems*. Results of this study showed that in case of high stereotype threat, men outperformed women but in reduced stereotype threat case, women performed better than men though difference was not statistically significant. Other researchers also conducted such format of studies and confirmed the same outcomes (cf. Chatard et al., 2007). Gender stereotypic effect even has been observed among university students who were already in mathematics major. Good et al. (2008) investigated 174 university students (2/3rd men and 1/3rd women) from the professional program of mathematics (in calculus). They found that gender biased stereotypes affect women even from upper level of ability group who opted most difficult mathematics course. On the one hand, these results clearly demonstrated that stereotype threat accelerates anxiety that diminishes cognitive capacity of girls. As Dweck et al. (2004) remarked that,

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[8] « les femmes doivent constituer leur rapport au savoir dans le contexte d'une société et parfois d'un milieu familial, où la croyance en la supériorité masculine est encore forte et où l'accès aux savoirs savants est doublement interdit du fait de l'origine sociale et du fait du sexe ».

[9] SAT-M: Scholastic Aptitude Test-Mathematics

> However, recent research on stereotype threat has argued that the burden of having to perform under the specter of a negative stereotype can undermine performance on a challenging task. Ironically, it is often those who care most and are most motivated to excel who are the most vulnerable to the impact of negative stereotypes (p.51-52).

Thus, it can be concluded that more a person care about her or his progress and accomplishments in a particular domain, the more she or he can be affected by the pernicious stereotypes about her or his ability (Ben-Zeev et al., 2005). One possible main reason of this phenomenon may be that, for women, if they enter into mathematics related disciplines or courses, it is their self-decision against social odds, therefore, they already maximized their motivational level for entering in this stream of study. The other truth is that, for females in mathematics pipelines, stereotypes of males' superiority in mathematics are still alive. As Good et al. (2008) also concluded that both men and women were found to believe that, "*other people thought that men were better than women in mathematics*". Thus an additional pressure of stereotype influences directly female's motivation degree and confidence (Graham & Taylor, 2002), and may suppress female's self-efficacy in mathematical problems.

Nonetheless, these stereotypes, which become threat for particular one gender, is a source of motivation for other gender. Why gender stereotypes against the ability of girls become sometimes a source of motivation, and why in the absence of such effect, males' performance reduces than females. The one possible reason may be that, in case of men, they pursue mathematics courses due to social expectations and supporting stereotypes about their abilities, therefore, even when they are less prepared or less motivated towards these courses, they are outnumber than women in opting mathematics. Therefore, in the presence of gender biased anxiety against girls, their self-efficacy enhances (Wigfield & Eccles, 2002) that support them to produce better results. And in refuting of stereotypes or gender-fairness situation, their low motivation and low degree of self-efficacy functions as the hindrance that can alleviate them in excelling their best possible efforts. Some researchers (Harter, Waters, & Whitesell, 1997; Pajares & Valiante, 2001; Schunk & Pajares 2002) affirmed that gender differences favoring middle school boys in mathematics self-efficacy and performance were nullified when gender orientation beliefs about the intelligence and competence were controlled. These results strengthened the fact that gender difference in achievement or attitudes towards mathematics, if it exists, is situational and temporary that may be removed or decreased by undergirding stereotypic free environment in the class.

In the following part, research is reviewed the development of students' self-perception beliefs in mathematics in the result of such stereotyped environement.

2.6 Students' self-perception beliefs in mathematics

Research in mathematics education has long been interested in exploring individual's learning abilities and mathematical achievements under the banners of cognitive, social and biological theories. The point of debate has always been, how to enhance student's capacity to learn mathematics, and to explore the factors & mechanisms that influence learning process. There are many factors and may be more than that have been encountered presently in research, whatever the influencing unit is, its effect is seen on student's capacity to perform in mathematics. Student's performance depends on her or his mental state. It is observed in research that students, even they are capable, cannot perform well in exams due to mathematics anxiety. On the other hand, research also documented that students perform well after the session of counseling. These facts show that, what they feel about themselves, what abilities they think they have, what impression they have about their capabilities, how they observe other's impressions of them, strongly direct the students that what should they do and how should they expose (Bong & Skaalvik, 2003). These feelings refer to self-perception beliefs, which, in turn, develop one's beliefs, values, motivation and interests.

Research on student's beliefs and attitudes towards mathematics always recognize student's self-perception beliefs as of core importance. Students having different self-perception beliefs perform differently in different tasks. Thus, it can be presumed that student's self-perception beliefs form beliefs and attitudes towards mathematics and learning in it. As Jacobs et al. (2002) remarked that, "children perform better and are more motivated to select increasingly challenging tasks when they believe that they have the ability to accomplish a particular task (p. 509)".

Self–perception beliefs inferred and influenced by numerous factors, mainly including, student' gender, SES, previous achievements, parents and teachers' related variables (that are discussed above), etc. Here these self-perception beliefs will be studied regarding mathematics and about capacity to do mathematics. This study is delimitized mathematics self-perception beliefs to mostly studied concepts of mathematics self-concept and mathematics self-efficacy. In the following part, reflection of research is presented delaing the issue of, what is mathematics self-concept and mathematics self-efficacy, and how theses constructs are different for boys and girls. In addition, what role they play in the formation of mathematics beliefs, interest and attitude towards learning mathematics?

2.6.1 Self-Concept in mathematics

The notion self-concept refined as self-theory that develops by individual about himself in the result of experiences (Epstein, 1973). This construct was introduced as the self-esteem by one of the first psychologist, William James in late nineteenth century who presented it as self-feeling in explaining "Me"; Me that becomes an object of person's thought and perceptions (Pajares & Schunk, 2001; Encyclopedia of Social Psychology, p.797). Self-concept is typically defined as the composite view of oneself (Bong & Saalvik, 2003) that deals with the cognitive and motivational dimensions. Coopersmith & Feldman (1974) described it as;

> beliefs, hypotheses, and assumptions that the individual has about himself. It is person's view of himself as conceived and organized from his inner vantage and includes the person's ideas of the kind of the person he is, the characteristics that he possesses, and his most important and striking traits (cited in Pajares & Schunk, 2001).

These conceptions or perceptions of an individual are formed through personal experiences with environment and their interpretations (Shavelson & Bolus, 1982). Thus self-concept is the individual's conception about his own abilities in a specific domain (Löchel, 1983). In literature, two types of self-concept as a construct are found; one is global or general self-concept and the other is domain specific self-concept. In general, Global self-concept is related to the psychological well-beings and referred to the general perception of the individual's abilities, whereas domain-specific self-concept is related to behavioral functioning (Rosenberg et al., 1995) that is required for specific task (Worrell et al., 2008). While explaining this construct, Shavelson et al. (1976) presented it as multifaceted and hierarchical concept that has both descriptive and evaluative dimensions, but this idea was opposed by Winne et al. (1977), who viewed this construct as more unitary. Though, both ideas seem contrary to each other in their constructional design of self-concept and have certain justifications for it too. However, both share some common grounds, when there is the question of individual's academic achievements and self-concept as general and subject specific.

In the context of education, general self-concept can be seen as general academic self-concept. Reyes (1984) described that academic self-concept refers to a person's "*perception of self with respect to achievement in school*" (p.559). Thus, in particular, self-concept in mathematics is seen as the part of the mathematics confidence: confidence in learning and doing mathematics, that is an important affective variable, affects the mathematics achievement. Reyes (1984) defined mathematics self-concept as the person's belief in his or her ability to do well in mathematics. Both viewpoints affirm the interdependence (without confirming the causal order) of self-concept and achievements but a question raises that, is there any role of non-academic self-concept of a student on their achievements or academic self-concept? To observe this relation, between non-academic self-concept and academic self-concept, researchers concluded that non-academic self-concept has little or no effect on the academic self-concept. Studies conducted by Hoge et al. (1990) and House (2000), for example, demonstrated that general self-concept or students' participation in non-curricular activities do not or weakly influence academic self-concept of both middle school students and adolescent students.

It is widely acknowledged that academic self-concept has a significant influence on the students' intentions towards learning and their academic performance. Research studies (House, 1995; Reyes & Stanic, 1998) demonstrated that high academic self-concept leads the students to earn higher grades. Researchers found that, students' expectations of success, their academic self-concept and their mathematics self-concept have positive correlation with mathematics achievement. Among these variables, students' academic and mathematical self-concepts are most significant predictors of their mathematics achievements. Further, in this relationship, mathematics self-concept is stronger than the general academic self-concept.

A great deal of research in the context of gender, achievement, socio-economic status, and geographical & race differences has explored the relation with the degree of mathematics self-concept. A number of researchers (Ma & Kishor, 1997; Reyes, 1984; Wang, 2001, 2006; Wilkins & Ma., 2002) affirmed a statistically significant relationship between the students' mathematics self-concept and the group differences. Wilkins (2004) examined this relationship on the 13 years old (grade eight) 290,000 students from 41 countries, data available from TIMSS (1995) survey. He reported that overall international sample of the students (in 39 countries out of 41) confirmed the positive and statistically significant correlation ($r = 0.11$, $p < 0.001$) between high mathematics self-concept and mathematics achievements. These results pertained even with controlling gender and age factors. When these countries were divided into two groups (upper and lower halves) regarding achievements scores, a statistically significant difference {$t(39) = 3.2$, ($p < 0.01$)} was found, that is, countries that were ranked high self-concept tends to have lower mean achievement scores than the countries with lower mathematics self-concept. In addition, evaluating the ethnicity association, it was found that Asian & eastern European countries were found at the bottom in the ranking with respect to mathematics self-concept which confirms the geographical effect on their self-concept in mathematics. Furthermore, regarding age effect, researcher quoted that elder students were significantly lower in mathematics self-concept than the younger students. They further confirmed that *students' self-concept declined as they grew older*. Regarding gender, males were found internationally significantly higher ($\gamma = 0.08$, $p < 0.001$) in mathematics self-concept than girls.

The result of above mentioned study regarding age effect confirmed in other research studies (for example, Chiu & Klassen, 2010; Hallam & Deathe, 2002; Wang, 2001). The projectile of the mathematics self-concept of the students with respect to their age demonstrate that the mathematics self-concept starts to develop in early years of preschool that keep on increasing till elementary school years (cf. Hallam & Deathe, 2002). Till this stage students' motivation to participate in mathematical activities enhance their confidence and hence conception of their abilities. The second phase of this projectile that falls from high position, starts usually from high school, where students confront more challenging and abstract mathematics and the pressure of social comparison. The other possible reason of decline in mathematics self-concept can be the students' more realistic awareness of their actual abilities and competencies (Schunk & pajares, 2002) and cognitive maturity to grasp the negative and positive aspects of their actions. In explaining the reasons of adolescents' decline in mathematics self-concept, Chiu & Klassen (2010) documented that "increased academic pressure, comparison with peers and uncertainties resulting from school transitions" may be the causes, which result in lowering students' perception of their abilities to cope up with the challenges of relatively difficult educational environment than the previous.

On the other hand, studies (Chiu & Klassen 2010; Randel et al., 2000) in gender differences examined under the mathematics self-concept mostly confirmed the superiority of boys regarding reporting more confident in mathematical abilities over girls. In another research, Manger and Eikeland (1998) studied the causal effect of mathematics self-concept and the mathematics achievement of 924 sixth grade students from 49 schools of Bergen. They revealed that though causal relationship between mathematics achievement and Mathematics self-concept was not possibly clarified, as it is a bidirectional relationship. Regarding gender differences, results showed that boys reported significantly higher mathematics self-concepts than girls with effect size (d) of 0.54, but their mathematics achievements were not significantly higher (with effect size of 0.18) than girls. In addition, these gender differences in achievements disappeared, and even girls surpassed boys, in task performances when the effect of mathematics self-concepts was controlled. This shows that girls' lower self-concept in mathematics effect their mathematics achievements, as researchers also quoted that "girls' lower mathematics self-concept is an obstacle preventing them from outperforming boys in mathematical skills and mathematical tasks" (p.14).

These gender differences in mathematics self-concept are unambiguous as our culture and societies discriminate girl and boy in the light of certain gender roles. As discussed previously, these gender roles that guide person's life by specific principals, influence her or his beliefs about abilities and preferences in life that imbalance the estimation of her or his self-concept apart of actual ability. As Marini (1990) remarked that,

> Individuals born in the society at particular time come to fill gender-specific roles via processes of socialization and allocation that operate throughout life. They internalize attitudes and beliefs, including gender stereotypes, that buttress existing gender differentiation and stratification (p.114).

Girls comparatively low in mathematics self-concept are because of lower social status, which is given to them, and because of belief that they are less competent (Hart, 1989; Jackson et al., 1994; Jaspars et al., 1983; Nicholls, 1975; Uttal, 1997). This injustice distinction further defines their attribution of their success and failure in the form of under and over estimation. Girls attribute their failure more to inability than their success to ability, whereas, boys demonstrate usually more self-defensive behavior and attribute their failure more towards *bad of luck* and success more towards *high ability* (Nicholls, 1975; Weiner 1972). Likewise, it evaluates the cultural differences too, the societies that are more culturally gender oriented (For example, Asian and western European countries) demonstrate such differences in estimation and attribution that are stereotypically linked with gender (Jackson et al., 1994; Pajares & Miller, 1994; Randel et al., 2000; Uttal, 1997; Wang, 2006; Wilkins & Ma, 2002).

After reviewing the profound relationship of research on mathematics self-concept; its concept and its role, in the following part, the other construct of self-perception beliefs, that is, mathematics self-efficacy is presented.

2.6.2 Self-Efficacy beliefs about mathematics

The belief that a person holds about his competency is a critical element in making a choice for an endeavor or decision to bring the task at hand. Generally, self-efficacy is defined as:

> people's judgments of their capabilities to organize and execute courses of actions required to attain designated types of [educational] performances (Bandura, 1986, p-391).

These self-efficacy beliefs of a student, when discussed in the academic perspective, about the educational task or activity in which she or he is engaged are constructed from the interpretation. This interpretation that a student uses to make in the result of her or his previous performance and mastery experience, and sometimes through vicarious experiences observing others to perform the similar task.

It is a general human nature that man wants to get success in whatever he is engaged with. In consequence, he tends to select such tasks in which the degree of his belief about the success is high and leave that activity in which his desired degree of accomplishment is lower. That is why, when there is success he tries to relate it to his internal factor like effort or personal capability, whereas in case of failure, it is referred to bad of luck or little effort.

The self-efficacy belief of a student helps him in determining his intensity of effort and persistence for a particular educational activity in a given situation, accepting it as challenge or avoid it. But how such self-perception in terms of self-efficacy develops?

Self-efficacy of a child that begins from the childhood, continue throughout the period of life. As a reply, there are mainly two major sources from where a child perceives his self-efficacy. The first source is child's own experiences through which a capacity of symbolic thought in terms of understanding the cause-effect relationship in any process or phenomenon. This enhances her or his self-reflection competencies. The other source is the environment, in which parents, teachers and others' expectations, help and beliefs about the capabilities of the child to succeed in a given task, and child's observations of the behaviors of others towards a particular activity. The information, through these sources, is thus, used by the child to develop and evaluate his personal belief of his ability to perform in a particular situation.

In case of mathematics, self-efficacy is the perceived ability of a student doing mathematics or to resolve mathematical problem at hand. Pajares (2005) defined *mathematics self-efficacy* as the "judgment of his capabilities to solve specific mathematics problems and perform mathematics-related tasks" in a given situation (p.300).

Mathematics self-efficacy measures include such statements that describe the student's competence or ask the student about the specific mathematics problem, for example; *how confident are you that you can successfully solve equation containing square root*? (Bong, 2002), *I'm able to achieve at least 70% marks in my mathematics course this year.* (Pietsch et al., 2003) or *I'm sure that I can* solve this problem (Item taken from the present study).

However, in the comparison of mathematics self-concept and mathematics self-efficacy, both constructs share some primary antecedents (like; past experiences, previous constructed knowledge, social comparison and influence) and presumed resultants (like; feelings, attitude, anxiety and behavioral actions) of the subjective judgment. Mathematics Self-concept and mathematics self-efficacy are two different constructs as we have observed through theoretical definitions of both construct that clearly defines the boundaries and dimensions of each construct. If we overlook above-mentioned items and compare them with the items previously given in mathematics self-concept topic, we can conclude mathematics self-efficacy as the context-specific assessment of one' mathematical competence. Whereas, mathematics self-concept which is multifaceted and hierarchically organized, does not deal with the specificity of mathematics problem, but is concerned with one's self-worth perception and confidence in one's abilities in mathematics. Pietsch et al. (2003) reported three key distinctions between these two constructs that are cited in research. These are:

- Whereas both constructs incorporate cognitive appraisals of the self, definitions of self-concept incorporate affective responses to the self.
- Self-concept beliefs are more heavily influenced by processes of social comparison than efficacy beliefs.
- Attempts to compare the productive utility of each of these constructs have demonstrated that efficacy beliefs have a stronger association with academic performance than self-concept. (p.589)

It is observed that mathematics self-efficacy is the cognitive assessment of students' competence (Bandura, 1977; Bong & Clark, 1999; Pietsch et al., 2003). Therefore, mathematics beliefs of students are formed on the bases of their mathematics self-efficacy, whereas, mathematics self-concept, as influenced more by social comparison, includes affective component. Therefore, self-concept may lead to the development of interest and confidence in mathematics that is viewed as the other component of mathematics attitude. Thus, it can be hypothesized that, both components: beliefs and interest vis-à-vis mathematics, that are imparted through the teacher's influence (in terms of behavior, beliefs, competency, etc), parents' effect and student's vicarious experiences (that are filtered through stereotypes too) are responsible in the formation of attitudes of students towards this discipline.

Regarding the role of mathematics self-efficacy in achievements, research (Carroll et al., 2009; Lloyd et al., 2005; Pajares & Miller, 1994) indicates that self-efficacy can predict mathematics performance more strongly than mathematics self-concept. Pajares & Miller (1994) studied this relationship on 229 female and 121 male undergraduate students in a public university. Study results showed that mathematics self-efficacy was more predictive of students' abilities to solve mathematics problems and strongly related to achievements. Further, males and females differed in mathematics self-efficacy and mathematics self-concept, though actual performances remain same. Females' lower judgment of their mathematical capabilities (than males) causes poorer performances and low mathematics self-concept. As researchers quoted;

> it should come as no surprise that what people believe they can do predicts what they can actually do and affects how they feel about themselves as does of that

task…[as it is observed] students' beliefs about their capabilities is important mediator and predictors of their performance (p.200).

Similary, Llyod et al. (2005) in their study also documented that girls from both fourth and seventh grade achieved relatively more scores in numeracy subtest than boys but girls still showed low confidence in their abilities. Whereas, the results for boys' mathematics self-efficacy revealed that they were relatively over confident relative to their actual academic achievement. Though, research quoted low or no difference in achievements score but girls' self-efficacy and self-concepts in mathematics were always reported lower than boys. This conclusion reconnects with the social influence on boys and girls that filters through certain gender stereotypes.

This extensive scholarship of literature review demonstrated, on the one hand, that parents and teacher, in one way or other, affects students' own perception about their abilities in mathematics. On the other hand, gender appeared as the moderating variable, which drives the intensity and sometimes effect (positive or negative) of the factors (social-cultural and psychological) in the formation of mathematics attitudes. Therefore, in the light of this perception, a gender difference in attitude towards mathematics may be evident. Various studies (references quoted in above discussion) explored this expectation empirically but there was inconsistency in the results. One of the possible reasons may be the crude measures of mathematics attitudes and measuring different aspects under the umbrella of mathematics attitude. As mentioned by Ma (2001) that, research on mathematics attitudes depended on three axes: "whether students like mathematics, whether they perceive it to be useful in their future and everyday life, and whether they are confident in their ability to learn mathematics (p.219)".

Here, a brief review of the findings of few studies, which are reflecting different aspects of mathematics attitude and pattern of findings, is presented. Therefore, it is also pertinent to explore research about the pattern of gender differences in mathematics attitude in order to understand the effect of the previously mentioned causes.

2.7 Pattern of Gender differences in Mathematics Attitude

Measurement of gender differences in mathematics attitude was fostered in research by the debate on the test anxiety and anxiety in mathematics some four decades before in 70's. In 1975 & 1976, Fennema and Sherman conducted two studies (FSMAS[10]) on grade 9-12 students (14 to 17 years old) and grade 6-8 students (11 to 13 years old) to measure usefulness of mathematics, and confidence for the mathematics achievement, along with other seven scales measuring socio-cultural effect. Researchers came to the conclusion that the power of socio-cultural factors influences the development of mathematics attitude. Results of these studies indicated no significant gender differences in the mathematics attitudes among boys and girls having similar mathematics backgrounds. Regarding confidence for success in mathematics, overall girls were found to have more positive attitude than boys over different grade levels. For the variable, "usefulness of mathematics", researchers found in their research that, girls of grade 12 demonstrated more positive attitude towards this aspect than their counterparts. Similar findings of "no gender difference", were found by Ma & Kishor (1997) in a Meta-analysis of 143 studies which measured mathematics attitude in terms of self-concept achievement. On contrary to Fennema-Sherman findings, they found significant decline in mathematics attitude from junior to senior students. In another cross-national study conducted by Iben, M .F. (1991) on the students of seventh and eighth grades from three countries; Australia, Japan and United States, a revised version of FSMAS was adopted to measure the ethnicity and gender differences. Researcher found mathematics attitude as a significant predictor of success in mathematics at early adolescent year (14 years of age). For the variable, usefulness of mathematics, regarding gender and ethnicity differences, relatively mixed results were found. Caucasian males from Australian and black females from US showed significantly better attitudes than their counterparts. These results indicated that ethnicity also plays a vital role along with gender in the development of usefulness perception of mathematics. Therefore, researcher affirmed that student's background characteristics and personality characteristics define the quality of effort. These findings somehow strengthened the conclusion of Fennema-Sherman of power of socio-cultural factors in the development of mathematics attitudes too. From another angle, Brown & Walters (2005) reported mathematics attitude as the possible cause of gender and ethnicity differences in mathematics performance. Similarly, the findings provided by Geary (1994) in a study also indicated the gender difference in attitudes in exploring the causes of mathematics achievements. Among various reasons, based on psychosocial and cultural factors,

[10] Fennema-Sherman Mathematics Attitude Scale; an instrument consisted of nine scales.

“perceived utility of mathematics” was found a significant cause of gender differences in mathematics achievement. Reflection of these studies indicates that gender and social background are variant variables for attitude in the sense of utility or belief of usefulness of mathematics.

Gender differences in attitudes towards mathematics, in another form, examined by Jagacinski et al. (1984) in terms of persistence of males and females in engineering field. They explored the factors that worked behind the males’ and females’ decision of adopting this field. They found a great proportion of females mentioned the influence of fathers, well-educated parents especially employed mothers them in taking the decision of adopting this domain as future career. On contrary, males adopted this field because of their own interest and hobbies. These findings indicate the difference in approach of a male and female towards mathematics and technology based field of studies. This conclusion, further, affirms gender differences in interest in mathematics at school level; for example, the results of TIMSS 1999, in which boys showed more interest in mathematics than girls in eighth grade. In addition, Catsambis (1994) found that; middle school boys reported significantly more interest in mathematics than girls, and high school girls declared need to adopt mathematics significantly more than their counterpart boys. If above findings are compared with what Catsambis found then it affirms the fact of gender difference regarding the interest and belief (which develops sometimes under the influence of social agents) of mathematics to continue this discipline in advance levels, in which, boys report generally more interest and girls report usefulness belief. Moreover, if we consider what Post et al. (1991) reported that, mathematics interest predicts the consideration of adopting mathematics related careers, and coordinate this finding with the conclusion made by Brown & Walters (2005) that, interest in mathematics and continue this discipline depends upon the capability of doing work independently. Then it can be deduced that, these are the social and cultural factors invade this sense of independency more in boys than girls, as confirmed by previously reported literature review also.

Therefore, keeping these conclusive reflections of research in view, a theoretical model that demonstrats the development process of attitude towards mathematics is proposed below.

2.8 Proposed model of formation of attitude towards mathematics

The research literature on theories in mathematics attitudes, and on the contributing factors in the formation of mathematics attitudes, reveal that, on the one hand, much work is needed for the elaboration of the theoretical conception of mathematics attitude. On the other hand, it reflects that lack of work on the modeling of the formation process of mathematics attitude, though a rich scholarship of studies done in order to explore the mathematics achievement and achievement-attitude relation is available. Therefore, the second prinicipal objective of current study, in accordance with first objective of theoretical conception of mathematics attitude, is to propose a theoretical model of formation process of mathematics attitude. The mathematics attitude, research indicates that it leads to the mathematics performance and decision to adopt this field of study as future careers. Further, to examine the role of social factors, (which are proliferated in research, e.g., parents, teachers, etc.) in the development of students' self-perception beliefs in mathematics and what relationship these variables develop in the formation of interest and belief about mathematics; a theoretical model is presented here in the light of literature.

This mathematics attitude formation model, in Figure 2.1, is based on two major sets of entities. The first set is showing the child, who is a boy or a girl, as a member of a family, is having general characteristics and aptitude. While, second set consists of important *socializers or exogenous variables,* parents and teachers. Parents, who provide an individual a certain environment to rear her or him up based on their socio-economic status, which includes parents' education, profession, family size and their income level. While, teacher factor includes gender, professional education, self-beliefs, her or his teaching experience and pedagogical skills. This model hypothesizes that both sets of entities with their initial characteristics pass through the social environment channel that consists of gender stereotypic beliefs, cultural norms and social milieu. This channel influences both child and socializers strongly, in result, they form their perceptions about the individual according to her or his gender.

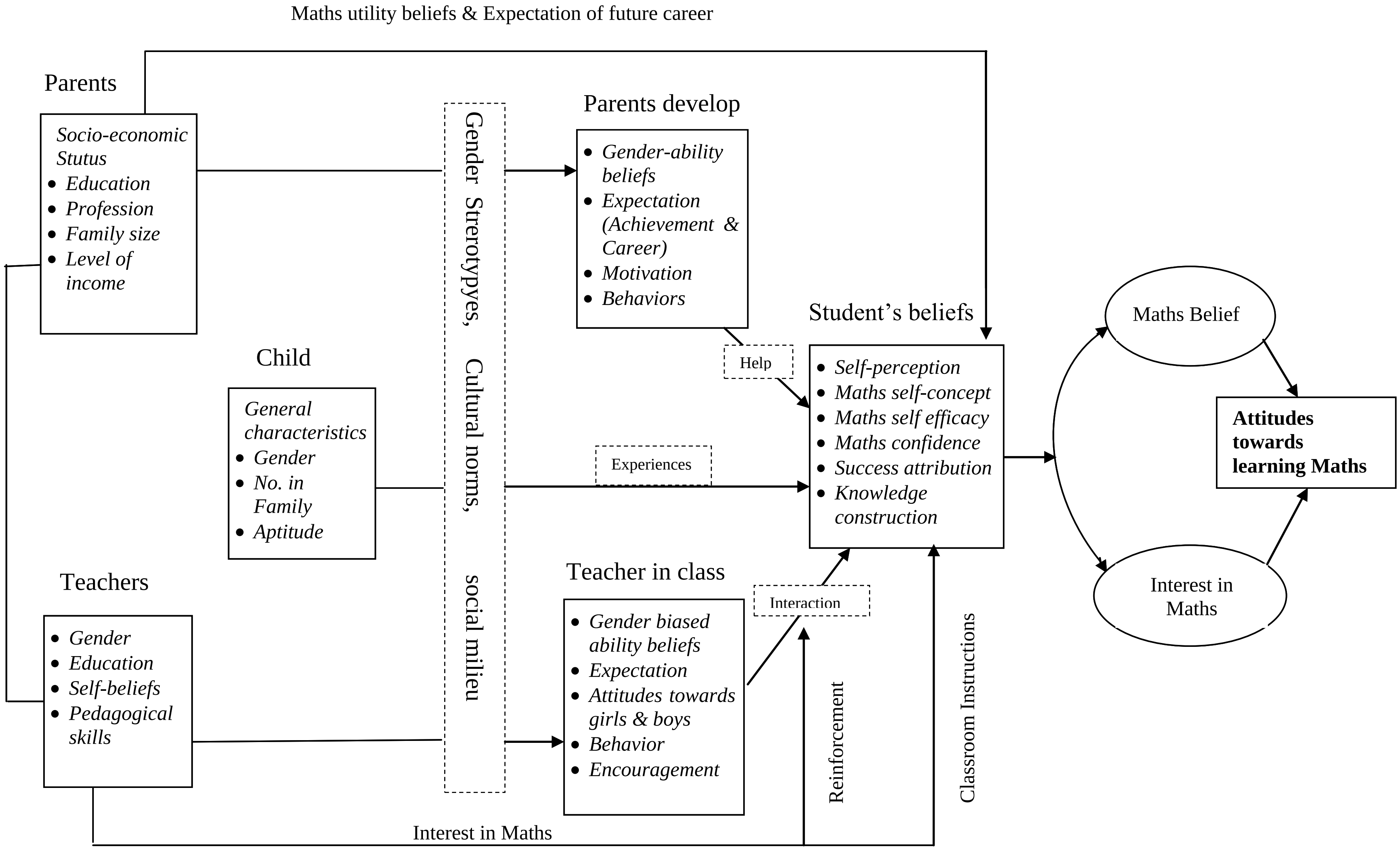

Figure 2.1. Model of Attitudes Formation towards learning mathematics

In particular, this model links individual and socializers through certain causal relations to form student's attitudes towards mathematics. Parents are linked with the development of mathematics attitude among students by two means, indirect and direct. In indirect link, parents pass through environment channel, which forms their beliefs about the abilities of their child as a girl or as a boy, and generate specific expectations about her or his achievement in mathematics and to proceed with mathematics related career. These expectations of parents guide their behavior and motivation for their child that works as a source of encouragement for her or him. This behavior and motivation externalizes in the form of their help, sometimes in doing mathematics (if parents are educationally capable to), or sometimes providing child extra private coaching (if parents can afford financially). On the parallel side, parents communicate their personal beliefs about the utility of mathematics through direct link to their child that help her or him to develop success attribution and mathematics beliefs. Usually mathematics related careers are seen as high earning professions, therefore, parents from middle class usually expect their child (both boy and girl) to choose such professions. Moreover, parents especially fathers if they are already from mathematics related careers are obvious to expect their child to adopt similar profession.

The other significant social agent is mathematics teacher. Mathematics teacher along with characteristics of gender, professional education, self-beliefs regarding mathematics, also pass through social transformer channel, when come in the classroom, is filled with gender specific beliefs about student's mathematical competencies, and expectation of better performance of one gender over other. In addition, her or his behavior and attitudes towards students conditioned with gender segregation, guide her or his interaction with them during lecture. Such teacher-student connection contributes a major part in the development of students' self-concept in mathematics. Teacher with her or his positive attitudes towards mathematics and pedagogical beliefs transfer the essence of interest in mathematics to students through direct connection. This direct link also reinforces teacher-student interaction and classroom instruction.

The core part of this model, the child, whose certain general characteristics, more notably, gender, number in family (sometimes it is observed that eldest child or a boy is usually considered as more privileged in the sense of parents attention and financial resources), his socio-economic status, and her or his mental aptitude, define the mode and intensity of experiences through societal & stereotypic filtration process. These experiences that may have different outcomes for a boy and a girl, are on the one hand, lead to the construction of knowledge and self-perception beliefs in the light of gender specific stereotypic social influence. On the other hand, expectations, interaction, and values transferred by social factors, and student's own experiances in mathematics, directly influence student's mathematics self-beliefs and mathematical competencies. These social cognitive variables that are influenced by cultural norms and stereotypic beliefs communicate gender roles to the student, which she or he uses to interpret her or his past experiences in order to construct knowledge and develop success aspiration. The most important element in this knowledge construction is student's own perception of expectations, encouragements and attitudes of socializers (social agents) towards her or him. What and how a child perceives parents beliefs for her or him through the lens of gender, and in school, as a student, what she or he perceives from teacher's attitude and she or he observes teacher's behavior towards her or him, is of crucial importance. These perceptions are pertinent in the development of self-concept and self-efficacy in mathematics, than what teachers and parents perceives about her or him.

These mathematics self-concept and self-efficacy beliefs that communicate with success attribution, along with the effect of real life relevance and interest in mathematics transferred by teacher, and mathematics utility and value belief for future career aspiration communicated by parents, develop into mathematics belief and interest in mathematics. These constructs, interest in mathematics and mathematics belief, together define initiation and attitudes of a student towards learning of mathematics and excel in this discipline.

As reported in the literature review that, along with gender, socio-cultural background plays a vital role in developing mathematics attitudes, therefore, next section addresses the education sytem and conditions in Pakistan. The section-two deals in two axes of literature: the first one deals with the education system in Pakistan, prevailing conditions and educational statistics, while the next one encompusses the studies done in the cadre of mathematics education to gain the insight in comparison with the scholarship of the cross-culture research.

SECTION TWO: EDUCATION IN PAKISTAN

Chapter.3 Pakistan Education System

3.1 Introduction

Education is the central pillar of development for any country. It is an established fact that progress and economic development of a country heavily depends upon the education system that it preserves for its nation. What type of nation we want? What expertise do we require according to the needs of the country? For the better survival, what future visions a country should have? An educational system is there to achieve these set goals by formulating the components, like; physical resources (schools, buildings, equipments, finance, etc.), human resources (teachers, educational experts, administrators, etc.), and curriculum under the certain process of policy.

This section is focused to address the educational system, and research conditions in Pakistan. In the present chapter we studied the educational infrastructure of Pakistan and the situation of education that prevails in Pakistan since the first day of its creation. In addition, some light is pondered on the condition of boys' and girls' education, and literacy in different parts of the country. In the next chapter of this section, research studies done in the cadre of mathematics education in Pakistan are discussed. In addition, the participation of girls in mathematics and engineering domains are also explored.

Following is presented a brief view of the Education system that prevails in Pakistan.

3.2 Education System in Pakistan

In 1947, after the independence from the British rule, Pakistan adopted the same under-developed structure of education system that British introduced in the Sub continent during its colonial times. Though with time, various changes and reforms were made in infrastructure and new standards were introduced to meet international standards but basic roots of English system still can be observed.

Pakistan's educational structure has five major levels that can be divided into two major folds; pre-university education and university education. The pre-university or school education consists of four levels. A brief introduction of this level of education is explained below.

3.3 School Education: A Pre-University fold

School education or pre-university education consisted of twelve years education. This education can be subdivided into three major levels under the labels of primary, middle, and secondary education. Primary education further can be divided into two levels, that is, pre-primary education and primary education. Similarly, secondary education also has two levels, that is, secondary school education and higher secondary education. A brief detail of these tiers and description of examinations, which are practiced in government schools, is given below.

3.3.1 Pre-Primary Education

Pre-Primary level of education is also named as Early Childhood Education (ECE) in which usually 3-4 years old children participate. It was combined with the formal Primary education in the Seventh Five-year plan 1988-93. Since then, Pre-primary classes have been practiced in primary public schools under the name of *Katchi Jamaat* or *Prep* class (preparatory class). Earlier to this, early childhood education or Pre-primary education has already been practiced in Montessori's or Nurseries and Kindergarten schools administered by private sector and Christian Missionaries. At this level, classical paper-pencil way of education does not introduce in these early years, rather children are educated through non-formal ways of education, and through activities and games.

3.3.2 Primary Education

Formal primary education consists of five years that starts for the children of age 5 years till 10 years equally divided into five classes from Class 1 to Class 5. Usually separate primary schools exist both for boys and girls for this level of education. However, sometimes coeducation primary schools also exist in rural areas where there are not enough schools to cater the demand of children's education. In some cases, primary education sections are also supervised by the middle and secondary schools.

Regarding examination system, in 1998-2010 education policy, government demolished the traditional examination system for the classes 1 to 4 instead a new system of continuous assessment was recommended for evaluating the students' progress throughout the academic year. After five years of primary schooling, the regional board of elementary education administers a standardized exam at the end of 5^{th} grade.

Since the birth of Pakistan, Primary education has been declared free and compulsory for every child and with the government efforts, text books are also provided free of cost to the students at the start of academic year[11].

3.3.3 Middle school Education

The next stage, after the primary education, is middle school education. This level of education consists of three years from Class 6 to Class 8 for the children aged between 11 years and 13 years. Normally, there exist single-sex middle schools for this level and sometimes secondary schools also organize these classes.

At the end of every academic year, students are assessed by an annual examination administered and prepared by school administration. But at the end of three years of middle schooling, like primary school, students are obliged to take standardized test organized and administered by regional board of education.

3.3.4 Secondary Education

In Pakistan, secondary education comprises of two years; grade 9 and 10, for boys and girls of age 14 years. Till middle school education, every student has to follow the general scheme of studies obligatory for all. This scheme of study includes Urdu and English languages, General science, Mathematics, Social studies and Islamic studies[12]. After middle school, students are offered the option to choose particular stream of study according to their field of interest. Usually in most of the Pakistan's schools, students have two options under the name of 'Science' and 'Arts' groups. Science group includes Physics, Chemistry, Computer Science and Biology subjects, and Arts group includes General science, Civics/Home-Economics, etc. However, mathematics, Urdu and English are compulsory subjects for all students. There are number of other subjects too, that the students may opt, but due to lack of expert teachers in such domains, school administration does not offer teaching these disciplines to students.

Concerning examination system, students are assessed by the standardized examination at the end of each year administered by the "Board of Intermediate and Secondary Education" of every district of the province. This two years secondary school

[11] Despite of all policy measures that have been undertaken, the goal of Universal primary education has not yet achieved. Statistics (APEM, 2008) shows that still half of the population is illiterate.
[12] Islamic studies discipline is for Muslim students, while, non-muslims are offered a substitute subject 'Ethics'.

education is called 'Matriculation' and the certificate that is given after the successful completion is, 'Secondary School Certificate' (SSC). Administration of examination at this level is always been a contention among the political parties. In Punjab, for many years in past, this examination has been held after the completion of two years of studies. But for the past fifteen years, every ruling party alters the mode of examination. Sometimes, this examination held after each year and other decides to continue the previous examination system, that is, annual exam after two years.

On the parallel side, technical education is another stream of secondary education. In All Pakistan Conference 1947, technical education was given high importance to produce technical workforce to meet the needs of the country. At secondary level there exists two years of technical education called 'Matric Tech' under TEVTA[13]. TEVTA has its own board for issuing diplomas and certificates. This certificate 'Matric Tech' is equivalent to SSC, thus a student with this certificate can continue education like other students. Similarly, Vocational education is also offered to young students and adults in vocational institutes. These institutes exist for both males and females, where short term (3 and 6 months) and one-year diploma courses are also offered to increase the technical workforce in the market.

3.3.5 Higher Secondary Education

Higher secondary education begins after the completion of Grade 10. This level of education comprises of two-years, which helds in Higher Secondary schools, Inter colleges or in Degree colleges. Like SSC, its examination also held under the district board of Intermediate and Secondary education. At the successful completion of two years of education, at this level, students are awarded 'HSSC[14]' certificate. This level can also be called a pre level for professional degree like; Pre-medical for continuing medical profession, Pre-engineering for pursuing engineering profession, I-Com[15] for commerce education etc,.

On the parallel stream in technical education, TEVTA offers three-year professional diploma of engineering called 'DAE'[16]. After obtaining this diploma student can directly

[13] TEVTA is Technical Education and Vocational Training Authority. TEVTA was formed by an Ordinance No. XXIV of 1999 promulgated by Governor of the Punjab.

[14] Higher Secondary Education Certificate.

[15] Intermediate in Commerce

[16] Diploma of Associate Engineering

join industry to continue their profession or they may continue further technical education or engineering.

After these twelve years of school education, in Pakistan next tier of education that is, university or higher education commence.

3.4 Higher Education

Higher education or post school education can be divided into two major types: Non-professional education and Professional education. Both types have their respective institutions. Here the stream of higher education is presented according to its type.

3.4.1 Graduate degree College Education

In Pakistan's Education system, two years degree program after the HSSC is called graduation. This is a degree awarded program and successful candidates are awarded a *Bachelor* degree by the university to which college is being affiliated. In graduate degree college, this program can broadly be subdivided into two main categories, that is, Science and Arts. For a bachelor degree with mention Science "B.Sc[17]", a student has to choose a combination of three science subjects as elective (like Mathematics, Physics, Chemistry, Statistics etc.,) along with compulsory subject (English, Islamyat, Pakistan studies). Whereas, for Bechelor mention Arts 'B.A', there is option to choose a combination of two subjects from Humanities or Social sciences and an optional subject along with same compulsory subjects.

To meet the international standards of academic years, degree colleges are also offering four-year Bechelor programs after HSSC, that is, "BS" or "Bechelor Honours". These days, four-year graduation program is getting more popular and is worthwhile in the job orientation market. Most of the universities in Pakistan are now offering these programs in their campuses.

Examination criteria for both programs is different, in the former two years program (B.Sc/B.A), University conducts a standardized exam to all students after the completion of two years of education. Whereas, 4 years graduation (BS) follows the semester system and

[17] B.Sc is Bachelor of Science; B.A is called Bachelor of Arts.

thus continuous assessment and teacher-made tests are used to evaluate the students' learning.

3.4.2 Professional College Education

As the name depicts that these colleges are developed to get the professional education, like; Medical College, Agricultural College, Commerce College, Engineering College, Education College etc. These colleges function on the parallel stream of degree colleges and universities. Such colleges undertake the whole educational process till the completion of the professional education. Few of them are autonomous institutes in their administrative infrastructure and awards degree, while, other are affiliated with universities. For example, King Edward medical college is now a university and have authority to award the degrees to their laureates but in past it was an affiliated college of university of Punjab.

Regarding the admission criteria in such institutes, after HSSC, students have to qualify the 'National Entry test'[18] to obtain the admission in these colleges[19]. However, in Education College, right after HSSC, a student can precede B.S.Ed[20] but the basic requirement for admission in B.Ed[21] is graduation degree at least. Such colleges also offer the degrees of M.Ed[22] and M.A education.

3.4.3 University/Master Education

University or Master education starts after 14 years of academics (Graduation). This education can be subdivided into three levels:

Master: it's a two years postgraduate program after two years of graduation. After completion of 16 years of academics, a degree of M.Sc/M.A[23] is awarded. However, after B.S (4 years), Master degree is not offered, instead a student can continue directly M.Phil[24].

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[18] National Entry Test is developed on the pattern of GRE test. It includes usually two portions one is general and other is for specific profession.

[19] This practise has been adopted in recent decade.

[20] Bachelor in Science Education

[21] B.Ed 'Bachelor of Education' is a professional degree to adopt a teaching profession.

[22] M.Ed 'Master of Education' can only be obtained after B.Ed.

[23] M.Sc is 'Masters of Science' and M.A is 'Masters of Arts'. M.Sc is 2 years of education in any Science subject along with a research thesis for the fulfillment of degree. However, for M.A, sometimes thesis is not an obligation to award the degree.

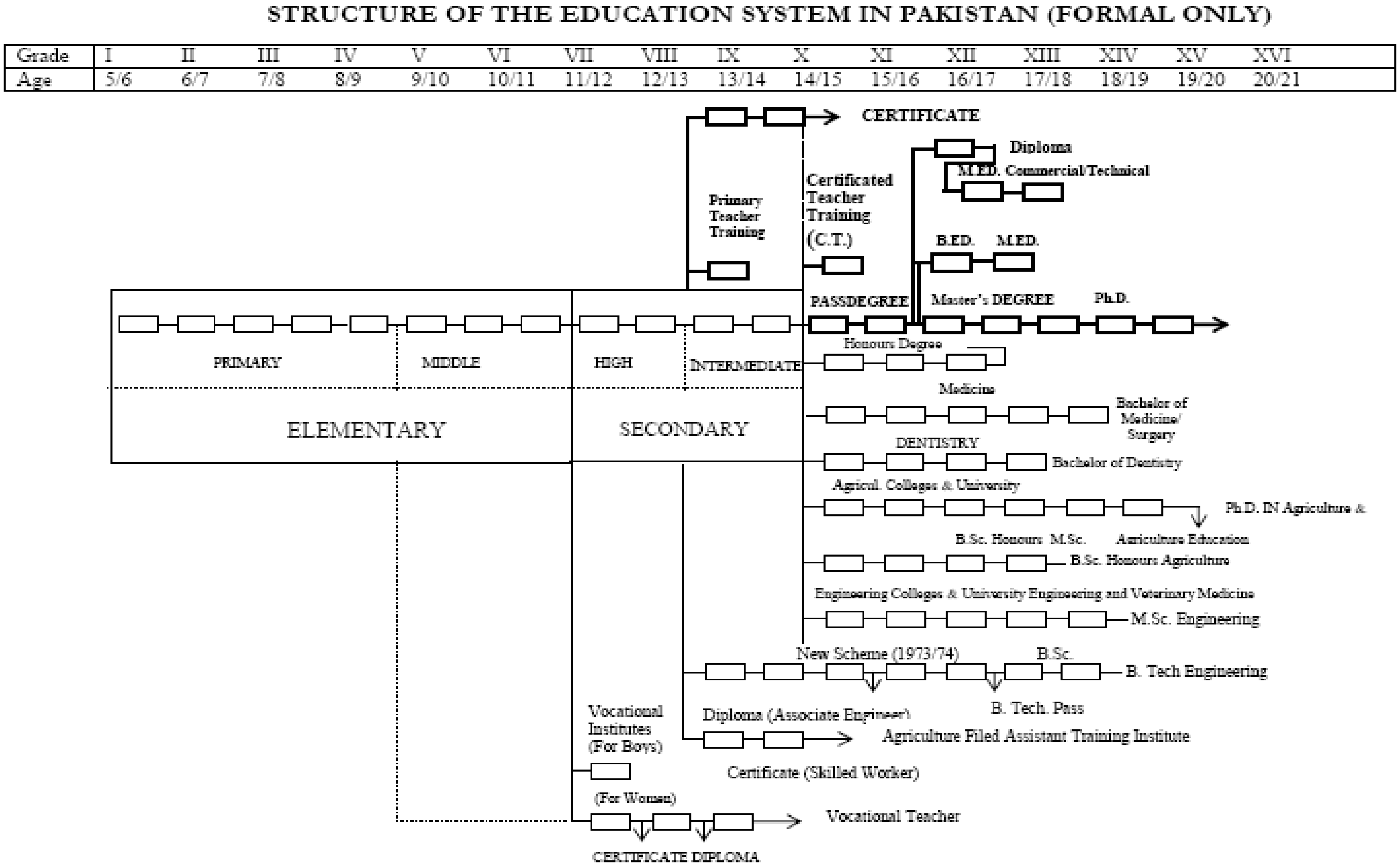
[24] M.Phil is Master of Philosophy degree in certain subject.

M.Phil: It is a 2-3 years postgraduate research degree program to continue higher studies for doctorate. In general, at this level, one year of course work, consisting of two semesters, and one to two year of research compiled in the form of thesis, is offered.

PhD[25]: This is the highest degree that is offered in any discipline in Pakistan. It is normally consists of three to five years of research, which is produced in the form of Thesis or Dissertation. After M.Phil, one can be enrolled in PhD, three-year research program. However, after M.Sc/M.A, one has to qualify one year of course work and qualifying papers before continuing three years of PhD research. Most of the leading universities of Pakistan are offering these degrees in various disciplines.

In the following page, hierarchy of structure of education in Pakistan is presented in the table 3.1.

[25] Ph.D is the abbreviation of Doctor of Philosophy.



Source: AEPAM, Ministry of Education, Islamabad, Pakistan.

Figure 3.1. Education Structure in Pakistan

To understand the conditions and reasons of problems, knowledge about the schools system that function like the backbone in any education system is pertinent to discuss. After having a comprehensive view of education structure prevails in Pakistan in next part of this chapter, the situation of education in Pakistan is discussed.

3.5 Schools System Prevails in Pakistan

In Pakistan, different school systems exist to meet the educational needs of the population. Generally, this system is depending upon three anchors, that is, Government sector, private sector and religious sector. All bodies introduce their own schools and follow their own syllabus and examination system. There can be other dissimilarities too, according to the area, management style, material resources, fee structure and socio-economic status of students and teachers. Description of this topology is given below.

3.5.1 Government Public Schools

Government schools or government public schools are those schools that are administered and maintained materially and financially by the government. Among them, mostly run by the provincial government and few of them run by the federal government. Staff (administrative and teaching) of such schools is appointed and paid by public service commission of provincial government or federal government. In these schools, Govt. offers not only free school education from grade 1 to grade 10 but also provides free of cost syllabus books[26] in the beginning of academic year to every student. Mostly students studying in these schools, come from low middle class and middle class families but very few come from poor class because they have to work to feed their families and thus can’t continue their education.

Basically there are three types of schools that exist according to the level of education, that is, primary schools, middle schools, and high schools. According to the social norms of Pakistan’s society, all are single sex schools except for few primary schools where co-education is observed when there is less population or shortage of school in a certain area. Similarly, the staff (both administrative and teaching) appointed in these schools is also single sex, even in mixed primary schools only female teachers teach the students except few schools in rural areas. All students (boys and girls) wear a particular uniform, the

[26] Free Books are provided till grade five.

national dress 'Shalwar and Kameez[27]' and additional 'dopata or scarf' for girls only. But in cities, boys in government schools mostly wear 'pantaloon and shirt' instead of national dress.

Government schools follow National curriculum that includes, Urdu language, Mathematics, Science, Social studies, Islamic studies and English language[28] as compulsory subjects throughout the school years. As Urdu is the national language of Pakistan, therefore, it is adopted as the medium of instruction and examination in such schools. In general, these schools, in the society, are therefore known as Urdu-medium schools. Two provinces KPK[29] and Sindh governments also use their regional languages 'Pushto' and 'Sindhi' respectively as the medium of instruction and an additional language in their school curriculum. All government schools follow the annual examination system, which held under the supervision of district board of intermediate and secondary education.

Although, these schools are run by the government, but the standard and facilities are not same in all schools, especially, this diversity further increases in the rural and urban areas. In urban areas and in cities, all schools have their buildings with proper administrative structure and teaching staff but mostly schools lack with the facilities of clean drinking water, furniture. Sometimes, proper buildings with play grounds and lack of teaching staff for large number of pupils are also the major problems. Further, the standard of the education is not quite up to the mark in most schools (though not all) because of too many students in a class, sometimes it ranges from 60 to 80 students in a class and only one teacher is there to teach and control them. Whereas in rural areas, this situation is worst. There are varieties of topologies of schools exist in rural areas, these are: ***(a) School without building:*** these schools are also known as '*chaar diwaari'* or four-walls school. Such schools do not possess any building or room for children but the four walls to show the existence of the school, which is further, not even present in many cases. Students of all ages and all grades from '*kuchi' and 'pucki'* [30] to class 5 sit under the shadow of the trees in hot summer and under sun in winter and there are always exceptional holidays when there is rain or any event in the village or teacher is absent. Students are sometime taught in the

[27] National dress for males and females; Shalwar is used to wear like pent and Kameez is long shirt.

[28] English is the official language of Pakistan, before 1995, it was offered from class 6^{th} but after the reforms in 1996, it was introduced from the class 1 and announced as the compulsory language like Urdu since from class 1 up till graduation.

[29] KPK: khebar Pakhtoonkhwa formerly known as NWFP 'North Western Frontier province' is the province of the Pakistan that consists of north-western and frontier parts of the country.

[30] These are urdu terms that means Nursury and Prep classes before grade 1.

form of groups and deliver lessons to all and promote students occasionally to next grade or next lesson on the bases of her or his personal judgment and assessment. Traditional method of admission of a student does not exist here, but it is up to the teacher to accept a child and enroll him or her on the attendance register. This type of schools exists in such villages where people do not have even basic facilities of medical dispensary or roads and even electricity. ***(b) One room school:*** as the name depicts that these schools consist of only one room where all students of every grade, sit in the same classroom and there is only one teacher to teach them and to continue the education process like four-walls schools. In such schools, teacher alone performs many functions; he is the teacher and the head of the school as well, and at the same time responsible for the school building too, so he is many in one. These types of schools exist in rural areas especially in the villages and up to primary level. ***(c) 'Taat'[31] Schools:*** such schools do not possess any furniture in the classrooms to sit but a building that consists of two rooms or more. Students get their education sitting on the floors the whole year in every kind of season. Usually, there is head teacher[32] who also works as administrator in the school along with two or more teachers to teach the students in the primary or middle school. ***(d) Furnished school or simply 'The school'***: This is a normal school having the building with sitting desks and other basic furniture in the classrooms for students along with a playground. These types of schools exist in relatively developed rural and urban areas. Standard of education in such schools is comparatively better than the schools that discussed above. These are mostly single sex schools like urban areas and cities schools but in the rural area, primary schools, discussed earlier, are mostly mixed schools.

3.5.2 Private schools

Private schools run and administered under the ownership of individual, private group or NGO's[33] management, and work on the parallel side of government schools in Pakistan. Almost all private schools offer subjects in English language (few exist in urdu medium too) and adopt English as a medium of instruction and language of examination. Private schools are considered to be a status symbol in the society as they charge huge sum of amount and labeled as english-medium. There is a variety of private schools that varies from 2-3 rooms

[31] Taat is a urdu language word that means a floor mat.
[32] Or a head-master or head-mistress in the high school.
[33] Non Governmental organization

school to elitist school, which are participating in educational system to provide the education to the youth of the country.

Before the birth of the Pakistan, private schools were established by the English authorities for elite class of South Asian people to inculcate british values and norms in their minds. The basic purpose was to develop the people of elite class in such a manner which will aid in strengthen the political and social cause of their rule in the sub-continent and be loyal to the crown of Britain (Rehman, 2005). In the colonial period, these types of schools were established only in big cities like; Karachi, Lahore, Bombay etc. Therefore, after the partition in 1947, this trend of private schools continued in big cities of Pakistan. But for the past two decades, the number of private schools of different types and standards is growing in both urban and rural regions to provide the English-medium education to the population.

Mainly there are four broad types of private schools that exist in our society: ***(a) Elitist English medium schools:*** These are only for the children belonging to elite class and upper class who are supposed to be the future chiefs, bureaucrats and part of establishment[34] of the Pakistan like earlier under the British rule. These schools follow only the British educational system (Cambridge or Oxford) or American's system, their curriculum, their examination system like 'O'[35] and 'A' levels etc. This kind of schools possess huge buildings, extra ordinary play grounds, well-equipped and centrally air-conditioned class rooms, and every facility that a person could imagine. These schools are not less than the elite schools in Britain in terms of facilities, environment, culture, and of course education and its charges. ***(b) Non elitist but above-average private schools:*** These schools are not elite but preserving the standards above the average private schools. They also charge huge fee that can be afforded by the families only from lower upper class and upper middle class. This type of schools follow British or American curriculum especially from grade 1 to 8 but after grade 8 they offer both Pakistan's National Curriculum and British Curriculum to their students. If a student wants to continue with grade 9 and 10 then she or he will follow district board's syllabus and examination system but if a students wants to do 'O' levels then he will follow the Cambridge or Oxford syllabus and examination system. ***(c) Average Private schools:*** These schools offer traditional English medium education to their students following a mixture of curriculums from grade 1 to 8 but strictly observe the National

[34] Establishment is used as a political term that means the personnel which control the government.

[35] 'O' level is slang for British GCE (General certificate of education) secondary-level academic education called equivalent to Pakistan's Matriculation. And 'A' level is Advanced level that is considered to be equivalent to the Pakistan's Higher secondary school certificate (Wikipedia-Free Encyclopedia, 2009).

curricula for grade 9 and 10 (SSC examination). This kind of schools can be found in urban and sub-urban areas and in houses of 6 to 10 rooms situated in residential colonies sometimes. Most of them do not meet the building requirement standards set by the government boards of education, especially lack of playing grounds. ***(d) Below-average private schools:*** These schools, as name depicts, do not offer often the quality education but a label of English medium school only. Such schools can be found in villages, sub-urban areas, urban areas, in the streets, consisted on 2-3 rooms.

There is another type of the schools, which are private schools but not for earning profit, these are called Community-based Schools. These schools are established and administered by the local community and NGO's. These schools establish in poor and deprived areas where there is no school for educating the children, while students are sometimes charged very small fee or free education. Normally, these schools offer primary level of education to the children.

Unlike Govt. schools, private schools charge heavy fee from their students, which is according to the status of the school, sometimes ranging from Rs. 200[36] to Rs. 25,000[37] per month approximately. If elite school or above average school is also a boarding school, i.e., it offers residence or the hostel services to their students then the monthly expenses may raise up to Rs. 50,000 (500€) to Rs. 100,000 (1000€) per month (Ali & Farah, 2007).

As English is an official language of Pakistan and in every gazetted job, English competency is the primary obligation to get the job. Therefore, this language, as a status quo, is considered to be the key of bright future and English medium students are privileged. Thus, parents want their children to be good in English. Furhtermore, by sending their children in such schools and paying handsome amount of money as their fees, they affirm their good socio-economic status in the society and develop their social circle with rich and key positioned people in the society.

3.5.3 The Religious schools

Apart of these Government and Private schools there is another stream of the schools, which is working to cater the demand of educating generations since many centuries and

[36] Up till recent currency conversion rate 1 = 100 rupees approximately.

[37] Data searched by the researcher from different web sites of schools and inquired through administration of the schools.

these are; “The religious schools”. In Pakistan, there are approximately 90% of the population belong to religion Islam, in which, different schools of thought can be found but the major proportion of the population belongs to ‘Sunni’ Sect. In these days, the institute that is considered to be the symbol for religious education of Islam is called ‘Madrassah’.

While in the case of minorities, Christianity belief is the biggest community among all non-muslims, consisted of approximately 7% of the total population. This community is also subdivided into different schools of thought, like; Roman Catholic, Protestants, and Jehovah’s Witness etc. To follow their respective believes and impart their education to the next generation, the Missionary schools were developed for this purpose.

The religious schools of these two religions have a rich history in the Sub-continent. Here, the structure and functions of these religious schools is discussed briefly.

Madrassah

Madrassah is an Arabic word, which simply means ‘School’, but this word is a symbol of a religious school for Muslims now a days. Madaaris[38] were present in all over the Muslim world to educate the people in the past and these exist in present days too. These institutes were the only and authentic source for getting education of both ‘Fiqah[39]’ and other disciplines like languages (Arabic and Persian), logic, philosophy, medicine etc. To get education and have knowledge is the obligation for every Muslim and to fulfill this obligation, Muslims used to travel far away from their homes. Therefore, in every Madrassah, there were arrangements for accommodation and food for these scholars since the early days of Islam. This practice is still continued, thus, in a sense Madrassah is a boarding school. History is evident that not only Muslims but non-Muslims had been benefited from these institutes.

In sub-continent, during the Muslims reign, Madaaris were founded for continuing the learning process and education for Muslims and non-muslims. But after the invasion of British in the sub-continent, the British hampered the road of the bright future of the Muslims of sub-continent by every means. In doing so, they quashed the Madrassah’s education and its certificates, and all of sudden whole nation became illiterate. They constructed their own schools for a particular class of the population called ‘elites’ or

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[38] Madrassah is singular and Madaaris is it’s plural.

[39] ‘*Fiqah*’ is a Arabic word that means the collection of rules and laws of Islam, dealings with actions, by which every Muslim is required to live. There are different fiqahs in different schools of thought of Islam.

British's faithful/loyal, to educate them in English, which was declared an official and obligatory language to get even a clerical job. Thus, Madessah that had a prominent status in the society, ignored and eventually destroyed administratively.

In 1947, there were 247 *Madaaris* in Pakistan and these were anchored on four sects of Islam, Barailwi, Deobandi, Ahle-Hadith and Shia (Ministry of Religious Affairs and Education, cited in Ali and Farah, 2007). Now *madaaris* have their own board of education called Pakistan Madrassah Board of Education at federal and provincial levels. These institutes offer 17 years of education from primary to post graduation that includes Urdu and English languages and Mathematics[40] along with other religious disciplines. These institutes are the best option for the poor community of Pakistan to get education, because they not only offer free of cost education, but also provide accommodation and food to their students. Figures revealed that there are now approximately 10,000 *madaaris* working in Pakistan (Buang, 2007). The total number of students who are getting education from these schools, may varies from one million to 1.7 million[41] that includes both types of students i.e., for short period and for longer period courses (Looney, 2003).

Missionary Schools

According to the dictionary, *Missionary* means a person sent by a church into an area to carry on evangelism. As mentioned above that the Missionary schools were developed in the Sub-Continent in late 17th century for Christian children to educate them and impart the religious education of Christianity to them.

During the British reign in Sub-continent, the British Christian Missionaries founded these schools for the children of common Christian man, and the army personnel of British and Irish. While, very few of these missionary schools were already set up by different Christian Volunteers and missionaries from France and Britain in late 17th and early 18th century. Like Madrassah, Missionary schools also belong to different sects and school of thought in Christianity like, Roman Catholic and Protestants (Presbyterian) etc. After the birth of Pakistan, Christians and other non-Muslims, got full freedom to practice their religion and open their institutes. The two main sects of Christians whose schools can be

[40] Mathematics is suggested till first 10 years of education. And English is proposed till 14th year of education.
[41] Total population of Pakistan consists of 180 million people, out of which youth (age: 1-25year) is approximately 50%.

found in every tehsil[42] of every district of the provinces of Pakistan are Catholic and Protestants. These schools are run by their respective education boards affiliated with their Churches. For example, the Presbyterian board of education is working under the Presbyterian Church of Pakistan and Catholic board of education is working under the Roman Catholic church of Pakistan. They prescribed their own curriculum and their own examination systems in their affiliated schools.

These schools offer high school education from grade 1 to grade 10 in English medium. In these schools too, education after 8th grade splits into two categories, that is, (i) Matriculation under the Regional Board of education like other public or private schools; (ii) O/A levels under Cambridge University. All Christian children get the religious education of Christianity and attend church prayers in their school churches but Muslim children are not offered this education. On the parallel side, to create the religious expertise, these schools offer religious education to adults who want to be the preachers and father/Pop of church.

Regarding fee, there is full or partial fee concession for Christian children but Muslim children pay full fee. Further, most of the Missionary schools possess their hostels for children. Thus, in general, a missionary school is also called a boarding school, which not only offer free education, but also free living with food to the deserving Christian children. There are some missionary schools that serve foreigners or elite class students and their expenses are equivalent to other elitist private schools in Pakistan.

3.6 Teachers' Education in Pakistan

The system of education usually stands on three main pillars, one is policies and plans which include physical resources too, other is administration and management and the third and most key positioned pillar in this tri-pod is "teacher". This is the teacher who on the one side, carry out all objectives and set goals of policies at micro level. On the other side, she or he is responsible to impart the values and norms of the culture along with the knowledge to the new generation, which help them to become a constructive unit of the society. In other words, it can be said that teacher is the transition gate in education system, through which, state transits its proposed goals towards realization. Thus, any intervention that can bring the change in the condition of education in a country, will have to be focused on the

[42] Administratively smaller than a district.

education and training of teacher. The personality development of the student and it achievement are directly connected with the teacher factor. Thus, teacher education is more complex phenomena than it is seemed. That is why, in the discipline of Education, the teacher education domain is given more importance than any other domain as it is not mere a pedagogy or mastery of knowledge but it conceals the counseling and guidance along with the capacity of dealing with different viewpoints of the society.

In Pakistan, province is responsible for the teacher education and training. Generally, there are particular colleges of Education (CGETs), Teacher training institutes and Allama Iqbal Open University, which offer education and training to in-service and pre-service teachers. These institutes offer degrees, diplomas and certificates according to the level of teaching. In primary schools, Primary Teaching Certificate (PTC) is prerequisite for applying for the post of primary teacher. While, for the post of Senior School Teacher (SST) and subject specialist, there is one-year degree program of B.Ed after the graduation that can be continued to M.Ed for further administrative posts. Private Institution also offer one-year elementary teaching diploma along with the short courses of three or six months. Table 3.2 shows some statistics of teacher training institutes and different courses and diplomas offered by them in Pakistan.

	Punjab		**Sindh**		**KPK**		**Baluchistan**		**Federal and AJK**	**Pakistan**
Sector	Institutes	Courses	Institutes	Courses	Institutes	Courses	Institutes	Courses	Institutes	TOTAL
Government	75	B.Ed, B.S.Ed, M.Ed, M.S.Ed, M.A and Short Courses	56	PTC/OTC/ATC, Refresher Courses, B.Ed, M.Ed, M.A Edu	47	DTC, CT, DM and Refresher Courses	28	B.Ed, M.Ed, CT/PTC, JDM, SDM	21	227
Private	7	PGD, B.Ed, M.A and MS (Edu. Psy).	24	PTC/CT, ADE, Short Courses, B.Ed and M.Ed.	10	JDP, SDP, B.Ed, M.Ed, CT/PTC and Short courses	2	B.Ed	5	53
Total	82		80		57		30		26	270

Source: AEPAM 2008 and UNESCO 2006.

Table 3.2. Educational Institutes and offered courses by province in Pakistan.

In Pakistan, total 270 institutes, in which 53 in private sector, are working for teacher education and training by offering a number of degrees, diplomas, certificates and courses. Scheme of studies of these courses and diplomas generally includes, Educational Philosophy, Educational Psychology, Administration and management, curriculum etc., along with the pedagogy of specified discipline.

In recent years, significant changes have been done, like; emergence of new institutes and restructuring of teachers' training. In this regard, Pakistan's first education university 'University of Education' was founded in Punjab in 2002. Further, Directorate of Staff development (DSD) Punjab was established in 2004. This development is responsible for the professional development of teachers and is improving the professional capacity by providing workshops, refresher courses and diploma to in-service teachers. Besides these, private institutes are also playing their role in raising the level of knowledge and updating with the modern skills in teaching profession.

Despite of these efforts, the standard of these programs is questionable, as Pakistan is still failed to improve the teaching in the class. Various research studies have reported the poor quality and performance of teachers in Pakistan (Halai, 2006; UNESCO, 2006; Westbrook et al., 2009;). The major reason for this fact is that, teachers' training institutes are failed to create a direct linkage between the teacher's education and courses offered and the real situation in the class. In addition, there is no single authority in the country to supervise and guide these institutes to improve their efficiency, and monitor the quality of education and training provided by these institutes (UNESCO, 2006). These problems can be tackled with proper planning and implementation of strategies.

Last but not least, lack of schools, buildings, physical and human resources are also another cause of the poor quality of education. Such issues should be addressed immediately in order to have positive progress.

After the brief introduction of the teacher education and teaching programs prevailed in Pakistan, below is given an overview of educational policies and plans introduced in Pakistan to cater the nation's need of education.

3.7 Education Policies and Reforms in Pakistan

In 1947, Pakistan was carved out on the map of the world after the fall of British rule in sub-Continent. Being newborn country, Pakistan had a number of problems ahead because of poor financial and human resources, and week administrative infrastructure in every sector. Among them, education sector was most deprived one, because, British developed a small number of institutions, which were situated in big cities only. Education system of British was aimed at educating only a certain group of people called elite class to rule over others. There was no concept of mass education in British colonial times, therefore, whole population living in rural areas was deprived of basic need of education. In result, after the partition of British India, Pakistan got huge population without education and few institutions which were insufficient to fulfill the needs of the young nation. At that time, Pakistan had only 16% literacy rate (ICG Asia Report, 2004). According to the official statistics of Federal Bureau of Pakistan, in 1947-48, the entire education system of Pakistan comprised on total 8,413 primary schools. Out of these primary schools, approximately 1,500 schools were for girls, while there were only 20 middle schools for girls out of total 2,190 middle schools. Whereas at secondary level, there were only 408 high schools, out of which, 80 were for girls. As far as higher education is concerned, there were only two universities in Pakistan at that time, in which female participation was equal to nothing (50 Years of Pakistan; FBS, 1998). Regarding enrolment in schools, there was again a big gender gap. Only 130,000 (13%) girls were enrolled in schools out of one million students at primary level (Economic survey of Pakistan 1986-87; ICG Report, 2004).

Thus, on the one hand, Pakistan was facing the problem of lack of schools to fulfill the educational needs of the nation in under-developed educational infrastructure. On the other hand, country was facing the major challenge of low literacy rate. Therefore, the founding father of the nation and the first governor general, Muhammad Ali Jinnah called first All Pakistan Education conference in the same year in 1947, which was called the first official policy statement on education.

In Pakistan, Federal ministry of education develops the National Educational Policy in the light of government's charter and constitution of the country. This policy then transmits to the Provincial education department to implement it through the plans that are chart out with the help of central planning commission and provincial planning department in the provinces.

During the 63 years of Pakistan since 1947, there were announced eight educational policies in total. Since the focus of the study is girls' education and gender equity, therefore, these policies are reviewed, too narrowly, in the light of these aspects. A brief overview of these policies is given below:

All Pakistan Education Conference 1947:

The first policy was developed in 1947 in the result of the "All Pakistan Education" conference's charter. In this conference, on the one hand, government emphasized on the five years of compulsory education for every child of 5 years to 10 years. On the other hand, adult education was set as a goal to improve the adult literacy rate in the country that was only 16% at that time. Since there were insufficient numbers of schools, especially for girls in those early days of Pakistan, therefore, to cater the need of the young nation, schools were allowed to commence the coeducation at primary levels by keeping local condition and societal adaptation in regard. The other prominent feature of this document was the emphasis on vocational education and technical training to create the technical workforce for the country. To implement this policy, in 1952 the Pakistan's first six-year plan was developed but no funds were allocated for this plan. Due to lack of resources and weak administrative infrastructure, these objectives couldn't be achieved till next policy in 1959.

National Education Commission 1959:

In this commission, compulsory primary education for all children was again set as a prime goal that could be achieved till 1974. For the first time, it was suggested that female teachers will be encouraged for primary schools to increase the females' participation, and thus, more recruitment of females in this sector was decided. To implement this policy, two five years plans (plan 1960-65 and 1965-70) during this period were prepared. The outcomes of these plans were not very different from the previous one because of non-allocation of the funds and lack of financial support (Ahsan, 2003).

Education policy 1970:

A new education policy was announced in 1970 with some new and few previous targets, for instance, the attainment of universal primary education till 1980 but this time it was proposed free of cost. In this policy, for the first time, to decrease the drop-out rate and increase the enrollment of the girls in primary, separate schools for girls was proposed and funds were also allocated. But this policy couldn't be implemented because of the war and political instability in the country, which resulted in the separation of East Pakistan into Bangladesh.

Education policy 1972-80:

In 1972, the new government of Pakistan announced the new educational policy, which targeted to achieve UPE[43] goal for boys till 1979 and for girls till 1984. To accomplish this task, "every possible effort will be made" was decided, like; construction of new schools, and construction of new rooms in already existing schools were planned especially in rural areas. Furthermore, double shift in schools and using official buildings and town halls for part time schooling was also encouraged. A great emphasis was made on the girls' enrollment. To accomplish this task, incentives, like; free meal and free education, were offered. Another thriving feature of this policy was the nationalization of all schools within the period of two years, to assure the education equity and gender equity in the education.

National Educational policy 1979:

This policy was announced with the slogan of 'Islamization of education' in the reign of General Zia's government. In addition, stepped back towards the denationalization of schools and coalition with private sector in promotion of education was stressed. In this policy, while maintaining the previous incentives of free text books and free of cost education, the mosque schools, both for girls and boys, were decided to open for achieving the goal of UPE and thus Madressah were given an equivalent status to schools.

National Education Policy 1992:

Like previous policies, in this policy too, main accentuation was on the acquisition of UPE goal and a great stress was given on the females' education. For this, in this policy, it was suggested that to increase the proportion of female teachers and females' participation in the field of education, a comparative relaxed selection criteria would be adopted for their recruitment. This policy was not very different from the previous all policies in terms of school education except the introduction of computer at secondary school level and introduction of English as a compulsory subject from grade 1 and for this addition recruitment of English teachers were suggested.

[43] UPE is an abbreviation of Universal primary education.

National Education Policy 1998-2010:

In this policy, government raised the slogan of '*Jihad*[44] against illiteracy' and planned to open 45,000 primary schools and nearly 20,000 Madressahs' schools to attain the UPE and increase the adult literacy rate through formal and informal education. A great stress was laid on girls' participation in educational process, especially in rural areas where gender disparity was immense. Other distinguished feature of this policy was the decentralization of education management to make educational services more effective and outcome oriented. During this period, with the change in political government in the country, under the new government of General Pervaiz Musharaf, on the parallel side of primary education, higher education was given enormous importance for the first time in the history of Pakistan. Higher Education Commission was launched and efforts were laid down on restructuring of universities' managements, creating new resources for them, construction of new universities, and up gradation of already existing degree colleges into universities and in result new women universities were also came into existence. Disparity and inequity in higher education was tried to reduce through providing equal opportunities to all. Irrespective of gender and other societal discriminations, scholarships were offered at national level in higher education. On the parallel stream, the plan 'Education for All' and 'Millennium Development Goal' were invested in the country to attain the goal of UPE. To promote the proportion of females and reduce the dropout rate in schools, along with free education a monthly stipend of 200 rupees was offered to every girl till secondary level.

National Education Policy 2009:

Recently a new education policy 2009 has been announced although period of previous policy in not over yet. Its salient features, regarding gender and equity, are; free and compulsory education up till secondary level, which now includes the expenses of stationary and books besides fees only. Equity in education regarding rural and urban areas and gender will be promoted, and for this, new schools will be opened especially for girls in rural areas. To ensure the full participation and enrolment of girls in education, it was proposed in this policy that food based incentives shall be introduced. Another salient feature in this regard is the introduction of special literacy skills programs which shall target the child laborers both boys and girls (14 to 17 years of age) and stipends will be given to rehabilitate them.

[44] Jihad means struggle and make efforts for right path.

The overview of policies given above reveals, that time to time, the government of Pakistan offered different incentives like, free education, free meal, monthly stipend and free books and stationary. Besides opening the new schools for girls to increase their enrolment and to reduce the dropout rate in the schools were additional objectives. Further, a relax criteria for females' recruitment was offered, especially in rural areas, to increase their participation for the development of the country. But apart from all these strategies, Pakistan yet could not realize the basic goal of universal primary education and 100% literacy rate.

This highlights the weaknesses in the policies in terms of unrealistic goals, which have been transferred in every next coming policy, like; 100% literacy rate and UPE. Moreover, the plans developed for their practical implementation had lope holes in terms of suggested methods and strategies to realize these objectives within stipulated time frame and in limited resources. The other thing, which was poorly administered, was the continuous evaluation of the progress of policies and plans. Here, it is necessary to mention that the allocation of financial resources for education sector is based on the annual economic growth of the country, that is, a certain percentage of GNP is allocated for every education policy. In 1958, total 1% of GNP allocated for the education policy (Ahsan, 2003). In 1998, this ratio could raise up to 2.2 % GNP (Ministry of Education). The amount allocated for education sector in terms of % of GNP demonstrates that education sector was never been in the list of priorities for the government of Pakistan. It is less than even the countries like; Sri Lanka and Bangladesh in the South Asian region, which have comparatively low GDP ($ 258.6 billion & $ 106.5 billio, respectively) than Pakistan ($ 464.9 billion[45]) but possess a better level of literacy rate. Here, a question arises that how can meager investment in this sector ensure the considerable progress and effective results? This question demands to study the situation deeply at grass-root level, to find out the causes of failure in achieving the basic goals of 100% literacy and UPE since the first day. Further, good governance and a strong mechanism of accountability in the implementation of education policies are imperative to implement for acquiring the expected goals (Ahsan, 2003).

In the coming part, a brief overview of the situation of literacy in pakistan is presented to understand the gap between the actual position and proposed goal.

[45] Source : https://www.cia.gov/library/publications/the-world-factbook/index.html. cited on 10-03-11.

3.8 Literacy in Pakistan

Education is a powerful tool to bring a positive change and indeed an estimator of future destiny of a nation. It is evident that the countries where the high literacy rate prevails, people usually avail better standards of living, prosperity, and better health facilities. Keeping this in view, constitution of Pakistan emphasizes on the introduction of free and compulsory education for every child of Pakistan. Although a number of efforts have been made to achieve 100% of literacy rate but Pakistan is still among those countries that possess the low level of literacy rate. According to Economic Survey of Pakistan 2007-08, after certain struggles, the literacy rate could raise up to 55%. Even this is not same in every region, as it ranges from 15% to 78% in different parts of the country, hence not a true representative of whole population of Pakistan. In this part, scenario of literacy rate is explored.

Literacy is the term that is broadly used for knowhow of reading and writing. UNESCO, created in 1946, has recommended a number of definitions during different periods of time depending on the set objectives from simple knowledge of reading and writing (UNESCO, 1958) to a continuum of learning that involves ability to achieve goals through knowledge (oral, written, digital and visual), potential and participation in community (UNESCO, 2003). All countries have adopted different definitions of literacy depending upon their resources and societal structure and then in the light of that definition, policy-makers set goals and design programs and strategies to acquire them. The most accepted definition of literacy by different countries that they adopted in their own way is:

"*Literacy is the ability to read and write with understanding a simple statement related to one's daily life. It involves a continuum of reading and writing skills, and often includes also basic arithmetic skills (numeracy).*" (EFA, 2000)

In Pakistan, the definition of literacy has been undergoing change in different time periods from simply writing "one's name" to writing a "comprehensive paragraph". The period of evolution of literacy definition can be divided into six stages. In 1947-48, for example, a person who knew how to write his name was considered to be a literate. But this definition then changed for the census of 1951 to "reading a clear print in any language". The next phase for the change in definition was the education census of 1961 in which the proposed definition for literate person was "one can read and understand the simple letter".

In 1972's education census, this definition was refined and declared that a person would be called literate "if she or he is able to read and write with understanding in any language". This definition then updated for the census of 1981 into the "ability of reading a newspaper and writing a letter" which persists till at present. However, there is a still space for an up gradation in the definition of literacy to meet the international standard proposed by UNESCO.

Universal primary education and adult literacy has been the prime provision of every education policy since 1947. But yet, Pakistan could achieve only 56% of the literacy rate that further varies from province to province, within the provinces and between the regions.

Comparison of data for literacy rate from 1947-2009 (16% to 56% in 63 years) delineates that on average, there is increment of 0.65% per year in overall literacy rate which is lowest among the South Asian countries and even in low income countries (worldbank, 2009). This discrepancy further widens in the case of females both in urban and rural areas. In rural areas 64% of the females are still illiterate, while in urban areas, this situation is little better where the ratio of illetracy among females is 35%. If we look deeply into the facts and figures presented by World Bank and Statistics bureau of Pakistan, with respect to the provinces and within the provinces, we will find more disparity regarding gender and regions. This literacy rate, that government is claiming to be 56 %, is in fact not the true representative of whole population of the Pakistan because it varies from 11% to 81% in different parts of the country (c.f. Table 3.3). Moreover, this gap further widens in the case of ratio of males and females in literacy rate. The following table 3.3 presents this fact in the scenario of gender and regions within the provinces.

		Rural					Urban					Total				
		Punjab	Sind	KPK	Baluch	Total	Punjab	Sind	KPK	Baluch	Total	Punjab	Sindh	KPK	Baluch	Pakistan
2000	Female	26 %	14 %	16 %	11 %	21 %	60 %	54 %	41 %	36 %	56 %	36%	31%	20%	15%	32%
	Male	51 %	51 %	55 %	49 %	51 %	71 %	74 %	70 %	71 %	72 %	57%	60%	57%	53%	58%
	Total	38 %	33 %	35 %	32 %	36 %	66 %	64 %	56 %	54 %	64 %	47%	46%	38%	36%	45%
2004	Female	35 %	18 %	23 %	13 %	29 %	66 %	62 %	47 %	42 %	62 %	44%	41%	26%	26%	40%
	Male	59 %	56 %	61 %	47 %	58 %	78 %	80 %	75 %	74 %	78 %	65%	68%	64%	64%	65%
	Total	47 %	38 %	41 %	32 %	44 %	72 %	72 %	61 %	60 %	71 %	55%	56%	45%	45%	53%
2008	Female	40 %	20 %	29 %	16 %	64 %	66 %	64 %	51 %	41 %	63 %	48%	42%	33%	33%	44%
	Male	66 %	57 %	65 %	58 %	34 %	78 %	81 %	79 %	84 %	80 %	70%	69%	68%	68%	69%
	Total	53 %	40 %	46 %	39 %	49 %	72 %	73 %	64 %	64 %	71 %	59%	56%	49%	46%	56%

Sources: 1- Pakistan Social and living standards Measurements Survey National 2005-06, 2006-07 and 2007-08.
2- Pakistan Social and living standards Measurements Survey: Provincial/District survey 2004.

Table 3.3. Literacy Rate among Provinces and Regions of Pakistan for the period of 2001-2008

The overall view of the figures gives in Table 3.3 an impression that Pakistan can be divided into two major parts regarding literacy rate. The first part that is consisted of Punjab and Sindh is possessing 59% and 56% of the literacy respectively. The other part consisting of KPK and Baluchistan are having 49% and 46% of the literacy rate respectively. Another interesting fact that can be observed is that the literacy rate is higher and consistent among males than females, in all four provinces, moreover, it remains highest in urban than in rural region.

However, among females, Punjab shows a better situation in all provinces, especially in rural areas, where literacy rate in rural areas ranges from 26% to 40% from 2000 to 2008 as compare to rural areas of other provinces. But the condition in Sindh and Baluchistan were weird where literacy among females (in rural areas) could raise up to 20% from 11% in 2000. While, percentage literacy in KPK is also not good but rate of increment is moderately better than other provinces, where it could attain 29% in 2008 from 16% in year 2000.

In urban regions, figures of Sindh and Punjab showed better literacy among females ranging from 54% to 66% during this period. In KPK, it was increased from 41% to 51% and Baluchistan is lowest among them, which could raise up-to 41% of literacy among females from 36% in these 10 years.

This disparity will be more culminating if it will be explored at ground levels, that is, among the districts of the provinces. This indicates that such parts of the country need more attention than other parts to overcome this diseprate situation. Unless and until these areas would not be improved towards better facilities of educating people, goal of universal education may not be achieved.

Present study was conducted in Punjab province; therefore, in order to understand better the situation of education in this region, in next part, some important educational statistics are discussed.

3.9 Educational Statistics of Punjab

The word Punjab is the combination of two words 'P*unj*' which means five and '*Aab*' means water, hence Punjab is the land of five rivers; '*Jehlum*', '*Chenab*', '*Beaas*', '*Ravi*' and '*Sutluj*' and consists of most fertile land in the South Asian region. This is the largest populated province of the Pakistan, containing 60 % of the total population of the country (Mohiuddin, 2007), and the second largest province in terms of area, consisting of 205304 Km² which is divided into thirty-six districts. It is situated in the Northeastern part of the country sharing its boundaries with other three provinces on its west side and India's boundary on its east side. 'P*unjabi*' is its regional language, which 95% of the population (Mohiuddin, 2007) understand, while, about 75%[46] can easily speak the national language '*Urdu*'.

The educational statistics that are given in Table 3.3 indicate that Punjab possesses a highest and comparatively consistent literacy rate among all provinces. As our research study is delimited on the districts of Punjab, therefore, in this section, some facts and figures regarding its institutes, enrollment and student-teacher ratio are presented to magnify the grounds of present research.

On the following page, a comprehensive picture of the ratio of schools and enrolments in them and, proportional to the ratio of regions and gender at different levels of education is presented in Table 3.4.

[46] Estimated from the education statistics of Punjab, given in "Pakistan Statistical Year book 2008" by Federal Bureau of Statistics.

		ELEMENTARY				SECONDARY			Overall Total
		Mosque	Primary	Middle	Total	High	H. Sec	Total	
Rural	**Female**	48	20,529	3,800	24,377	1,105	118	1,223	29,802
	(Enr)	(60,066)	(2,034,058)	(956,334)	(3,050,458)	(598,575)	(NA)	(NA)	
	Male	4,871	19,822	2,637	27,330	2,305	167	2,471	25,600
	(Enr)	(229,753)	(2,417,376)	(816,780)	(3,463,909)	(2,082,931)	(NA)	(NA)	
	Total	4,919	40,351	6,437	51,707	3,410	285	3,695	55,402
		(289,819)	(4,451,434)	(1,773,114)	(6,514,367)	(2681,506)	(NA)	(NA)	
Urban	**Female**	25	2,276	551	2,852	507	71	578	3,430
	(Enr)	(11,709)	(378,278)	(244,347)	(634,334)	(613,259)	(NA)	(NA)	
	Male	815	2,057	409	3,281	628	52	680	3,961
	(Enr)	(41,084)	(412,713)	(211,274)	(665,071)	(654,391)	(NA)	(NA)	
	Total	840	4,333	960	6,133	1,135	123	1,258	7,391
		(52,793)	(790,991)	(455,621)	(1,299,405)	(1,247,650)	(NA)	(NA)	
Total Govt. Schools	**Female**	73	22,805	4,351	27,229	1,612	189	1,801	29,030
	(Enr)	(71,775)	(2,412,336)	(1,200,681)	(3,684,792)	(1,211,834)	(NA)	(NA)	
	Male	5,686	21,879	3,046	30,611	2,933	219	3,152	33,763
	(Enr)	(270,837)	(2,830,089)	(1,028,054)	(4,128,980)	(2,737,322)	(NA)	(NA)	
	Total	5,759	44,684	7,397	57,840	4,545	408	4,953	62,793
		(342,612)	(5,242,425)	(2,228,735)	(10,252,838)	(3,949,156)	(NA)	(NA)	
Total Pvt. Schools		28	10,377	17,363	27,768 (34,92,025)	8,948 (1,52,390)	481[47]	9,429	37,197

Sources: 1- Pakistan Education Statistics 2006-07, AEPAM 2008.
2- National Education Census 2005, AEPAM.

Table 3.4. Number of Institutions and enrolment (Public and Private) by Region, Gender and Level in Punjab.

[47] It includes intermediate and degree colleges both.

The figures, illustrated in Table 3.4, confirmed this fact that more than 110,456 institutes (National Education Census, 2005) at different levels are taking part in the educational infrastructure of Punjab. Government with the help of private sector is trying to provide education facilities to young generation. In addition, the government of Punjab has opened more institutes for females than for males till elementary level to increase females' participation in education in both urban and rural regions. But this situation inverse in secondary schools and this gap further increase for higher secondary institutes both in rural and urban areas. As far as the students' enrolment is concerned, in these institutes, males are greater in number than females almost at all levels and this gap increases with the increase in education level. For instance, at elementary level, females are one half in number than males and this pattern moreover, can be observed in high school where girls decreased to one third as compare to two-third of boys and in rural areas this ratio further decreases to less than one fourth. If we study this pattern in depth, it can be found that in rural region, approximately half of the girls do not get enroll in middle schools after primary level education, which further decreases to 50% of previous enrolment in high schools. In total, as compare to 3,050,458 girls till elementary level, only 598,575 girls, which is 20 % of the previous enrolment, could continue their education in high schools as compare to 60% of boys. In other words, 80% of girls (12-13 years old), comparing 40% of boys, leave education after elementary school, which may be the major cause of these huge gender differences which later widen in higher levels. This sudden decrease in enrollment rate raises many questions that may be addressed in indicating different factors which work behind this phenomonon.

With respect to ratio of overall enrolment at different levels, total enrolment in pre-primary and primary level shares 73% of the total enrolment, while, at middle school level, it is diminished to only 18.57%. This ratio decreased to 7.98% for secondary level whereas, at higher secondary level it reduced to 0.45%.

The student-teacher ratio in class also varies from level to level. The overall student-teacher ratio at primary level is 56:1, which is decreased at middle and high school to17:1 and 7:1. It seems to be satisfactory except at primary level, where for every 56 students there is only one teacher and this ratio may vary from urban to rural region, whereas, at high secondary level this is increased to 31:1(PSLM, 2007).

Other institutes such as technical or professional, vocational, federal board schools, *madaaris* and community schools are also working at parallel stream to provide education at different levels. In total, near 110,000 schools and institutes, in which government institutes are more than 60% of total, are working in Punjab to cater the educational needs of the Punjab population.

In the sector of higher education, there are 36 (Public = 20 and Pvt = 16) universities and degree awarding institutes, out of total 120 in whole Pakistan, working in Punjab. The total number of students that are enrolled in these institutions were 1,46,000 which represents only 0.18% of the total population of Punjab (approximately 80 million) and among them females were only 57,956, that is, 0.07% of total population (AEPM, 2007). These figures depict that number of institutions, further, balance proportion of these institutions in every district of the Punjab, needs to be increased to cater the educational needs of the youth.

3.10 Conclusion

Education plays a key role in the socio-economic development of the society. An education system is an important element which ensures the situation of development in a country. In Pakistan, the quality of education as well as its availability is the main concern, which has been focused in all educational plans, reforms, and policies. The general problem, which Pakistan is facing since the first day, is the low literacy level in the country. Though, government claims of the hard struggles to raise this rate, but, on contrary, allocates least budget in this sector. On average it has never been more than 2.3% of GDP which indicates that this sector is not the highest priority of the government.

There is another major problem, that is, the multiplicity of the educational system in Pakistan. There are various systems of education are functioning, on the bases of which, different types of school systems can be found everywhere in the country depending upon the socio-economic status of the people. This diversity between the public and private schools, among the private schools, the rural and urban region based schools, missionary school and Madrassah, create the diversity in the quality and standard of the education in the country. This causes, further, generation of different classes in the society, who posses very less values in common while vast gaps in thoughts and modes of lives among them. A particular class consists of few privileged families always remained the ruling class and keeps major portion of the country's wealth in their hands. This situation, resources in few hands, increases the poverty and reduces the balance and harmony in the society. The injustice and imbalance division of resources can only be controlled by the uniform education which will be provided to all and without any discrimination.

Moreover, the quality of teacher education yet another task, that is still questionable. It is an established fact that the teachers are the transformers for the quality education. In this regard, a number of reforms and plans were introduced to raise the standards of teachers training but the required results of quality training and education of teachers could not achieve. The fact is that, teachers training courses and degrees are still taught in a traditional way like other programs in universities, which eliminates the purpose of the training. Further, the content of these programs of teachers' training are not up to the mark to meet the international standards. Therefore, the substantial impact on the quality of education in the institutes cannot be acquired unless the reforms based on broad spectrum of personality development to professional development of teachers will not be introduced.

In addition, regarding educational policies, we observed that neither any policy nor any plan could have achieved its objectives successfully. On the one hand, the reason for this dilemma may be the unrealistic approach while setting the goals. These were never based on the reality grounds and hence couldn't be more than the ears catching slogans. On the other hand, government never allotted enough or true amount of funds to realize these goals in to reality. Another cause of failure of these educational policies or mal-success of these plans may be the poor system of monitoring and lack of continuous evaluation process for them that could alert governing authorities to take necessary actions to obtain maximum output out of the minimum investment for the implementation of these polices. That is why after 62 years of Pakistan's independence, yet it could not realize the dream of 100% literacy into reality. Besides this goal of UPE and 100% literacy, there is another issue that couldn't be resolved yet, that is, gender equity neither for enrollment in schools nor in the successful completion of the studies.

In this chapter a detailed preview of education system and problems in Pakistan's education structure were discussed. In the next chapter, girls' education, gender differences in achievements and research in mathematics education in the scenario of Pakistan is presented.

Chapter.4 Mathematics Education in Pakistan

4.1 Introduction

Gender equity in school's enrollment and minimizing the gender gap in Universal Primary education have been the primary goals in educational policies developed by Pakistan's government. In the previous chapter, it was revealed that half of the population is still illiterate. Due to this literacy rate (57%), Pakistan is at lowest rank in education sector among the countries of the region. Gender gap in education is yet another issue that is to be resolved. Approximately, 56% of females comparing 31% of males are still illiterate and this imbalance of literacy among males and females further is increased when observed within provinces and regions or districts. For example, minimum literacy rate can be observed in rural area of Baluchistan where only 16% of girls are literate against 58% of males (cf. Table 3.3; PSLM, 2004). According to the national statistics of Pakistan, the ratio of total enrollment in schools among girls is 43% as compare to 57% of boys. This enrollment percentage further decreases in advance levels of education. Only 294,997 women precede higher education comparing 345,064 men out of total population (PSLM, 2008-09), whereas in universities, there is only one female among every seven students (Jehan, 2000). Therefore, the condition of gender disparity in professional careers can easily be imagined through the percentage of women proceeding in higher education. According to the international Workforce map for women, only 10 to 20 % of the women are paid workers in Pakistan. Due to this ratio, Pakistan is among the lowest ranked countries in the world, while for developed countries, like USA, France, and UK, this ratio is above 50% (Wilén, 2006).

Pakistan is a developing country and facing many problems, among them, an important one is, mismanagement of the resources. The skillful technical labour force in the country is the major resource that can accelerate the economy of the country. On contrary, Pakistan is unable to use its half of the youth pool consisted on females. This gender inequality in education and further in professional careers creates impediment in the economic development of the country. Whereas, the fact of gender difference also depicts that Pakistan has highly gender segregated society (Halai, 2006), where gender roles and responsibilities are strongly defined. This discrimination promotes the effect of other factors, like; lack of access to school, educational expenses, household duties, acceptability of single sex schools only, non-availability of female teachers especially for girls, low interest in education for girls, high drop-out rate of girls after primary education, etc. Due to these factors and obscurantist beliefs, girls are more likely to be kept out of schools and hence receive less education than boys (Farooq, 2009).

In an Economic survey (PSLM) 2007-08 conducted by Federal Bureau of statistics, Islamabad, the reasons for the dropout in primary schools were explored. In this survey, 10-18 years old boys and girls, who left schools without completing their primary education, were asked the reasons for leaving the schools. In total sample, 53% of the boys and 47% of the girls participated in this study. The reason indicated by most of the girls was, “parents’ unwillingness” to continue the education. In all four provinces, 7% to 29% of the girls mentioned that their parents didn’t allow them to continue the education as compare to 2% of the boys. These results further provide an evidence of the gender discrimination, male domination, and strict constraints for females, which are deeply rooted in the Pakistani society. There were other factors too, for example, 7% of the girls as compare to the 4% boys mentioned that the schools education was expensive for them, and 7% of the girls against 0% of the boys mentioned that the school was too far to access the education. Further, in this survey, the other group of girls and boys who never attended any formal school was also asked to enlist the reasons of not attending the school. In total, 47% of the girls compare to 5% boys indicated the parents’ unwillingness for them to get formal education. Ratio of these children was 20% more than those who enrolled in the school at least once in their life. The other prominent cause for girls of not attending the school was that, they had to help in homes. Out of total, 4 to 21% of the girls mentioned this factor as the main reason for leaving education in their primary schools. Whereas, majority of the boys (33-44%) mentioned their own unwillingness towards school education (PSLM, 2009).

Other research studies (Saeed et al., 2005; Llyod et al., 2005; Warwich & Jatoi, 1994), also affirmed that girls’ enrollment in schools especially on rural side, highly depends on the easy access to schools with free education and the parents’ willingness to send them in schools. While for boys, parents show a strong interest towards their education even in the case of schools are far from home, or even not present in the village. Regardless of their economic position to afford their educational expenses, they spend more money or even take loans for the education of boys. Llyod et al. (2005) described two main reasons of a girl is less likely to enroll in school: one was that, her mother was never been to school and unwillingness and second one was low interest of parents towards girls' education. If this finding is compared with the results of the Education census, in the light of literacy rate and rate of enrolments in different parts of the country, then a cause and effect situation can be assumed. Mothers with no education less likely to send their daughters to school, and in consequence these girls, in future as mother, may repeat the same situation, whereas, unwillingness of fathers, in addition, accelerate such condition.

This scenario of girls' education, and strong social and cultural barriers depict that, educating a girl is usually not taken as the basic right of the girl rather it has been assumed as a privilege for girls. Whereas in case of boys, it seems an obligatory right of them as they are suppose to lead in the society and run the families. Relative to this picture of inscription of girls and boys in schools, and society's approach towards educating them, next part addressed the girls' and boys' achievements in school.

4.2 Success rate of Girls and Boys

Previous insight of the studies showed gender difference in the total enrolment rate in Pakistan's schools, favoring boys both in urban and rural areas and in public and private schools (AEPAM, 2008; Farooq, 2009; NEMIS, 2006; *Pakistan Statistical Year book 2008*, 2008). However, it is interesting to note that the passing rate of girls in examination was more than the boys both at secondary education and higher secondary education levels almost in all provinces of Pakistan. According to the Pakistan Education statistics (2005), 65% of the females qualified the SSC examination as compared to 59% of the boys and in HSSC examinations, 66% of the girls succeeded in the exams as compared to 52% of the boys (Shami, 2005; Shami & Javed, 2006). From the databases of census from AEPAM[48] and FBS[49], statistics of students' enrollment and passing percentage for years 2001-2006 were collected in Table 4.1.

[48] Academy of Educational Planning and Management
[49] Federal bureau of Statistics, Pakistan.

Years	Gender		Arts Group	Science Group	Total
2001	Girls	Appeared	314583	155162	469745
		Pass	165604	104971	270575
		% Pass	**53%**	**68%**	**58%**
	Boys	Appeared	323540	480632	804172
		Pass	105482	256963	362445
		% Pass	**33%**	**53%**	**45%**
2002	Girls	Appeared	315014	162108	477122
		Pass	171634	117660	289294
		% Pass	**54%**	**72%**	**61%**
	Boys	Appeared	321298	450979	772277
		Pass	117849	268115	385964
		% Pass	**37%**	**59%**	**50%**
2003	Girls	Appeared	344613	188047	532660
		Pass	185197	140245	325442
		% Pass	**53,7405728**	**74,5798**	**61,0975**
	Boys	Appeared	346975	516079	863054
		Pass	111752	305613	417365
		% Pass	**32%**	**59%**	**48%**
2004	Girls	Appeared	307402	211208	518610
		Pass	260327	188411	448738
		% Pass	**85%**	**89%**	**86%**
	Boys	Appeared	275210	533972	809182
		Pass	183193	447936	631129
		% Pass	**66%**	**84%**	**78%**
2005	Girls	Appeared	396430	249060	645490
		Pass	197175	190083	387258
		% Pass	**50%**	**76%**	**60%**
	Boys	Appeared	335945	642138	978083
		Pass	110769	369295	480064
		% Pass	**33%**	**58%**	**49%**
2006	Girls	Appeared	328166	231999	560165
		Pass	200722	190250	390972
		% Pass	**61%**	**82%**	**70%**
	Boys	Appeared	277238	541092	818330
		Pass	110613	375586	486199
		% Pass	**40%**	**69%**	**59%**

Source: Pakistan Education Statistics 2005-06, AEPAM.
Pakistan Statistical year book 2008, FBS.

Table 4.1. Passing ratio of girls and boys in both streams of studies in SSC exams.

Educational statistics for six years; 2001-2006, in Table 4.1, offered a comprehensive picture of the fact of trend of gender and field of study, and the school achievements. From the figures, given in table 4.1, an interesting pattern along with the low proportion of girls as compare to boys appearing in examination can be observed, that there were always two third of total girls appeared for Arts group and one third for science group. Whereas the case is opposite for boys, out of total enrolment, in all six years, two third of total boys always appeared for science group and one third appeared in Arts group for SSC examination. The pattern of this ratio between girls and boys for science and non-science groups can be observed in other parts of the world too (Wélin, 2006). These figures affirmed the general perception of utility of science and technology for boys for their future careers (TIMMS, 1995). The pattern of such behaviors sometimes invaded through societal setup where society is highly segregated with respect to gender and sometimes embedded by stereotypes about these professions as male professions (Good et al., 2008; Jacob & Eccles, 1985; Fennema, 1981).

The other interesting fact that was discovered from this analysis of statistics is that, the passing ratio of girls is more than the boys. To study the pattern of success in the examinations at secondary level in both streams of studies, passing ratios of both girls and boys are drawn in graph in Figure 4.1.

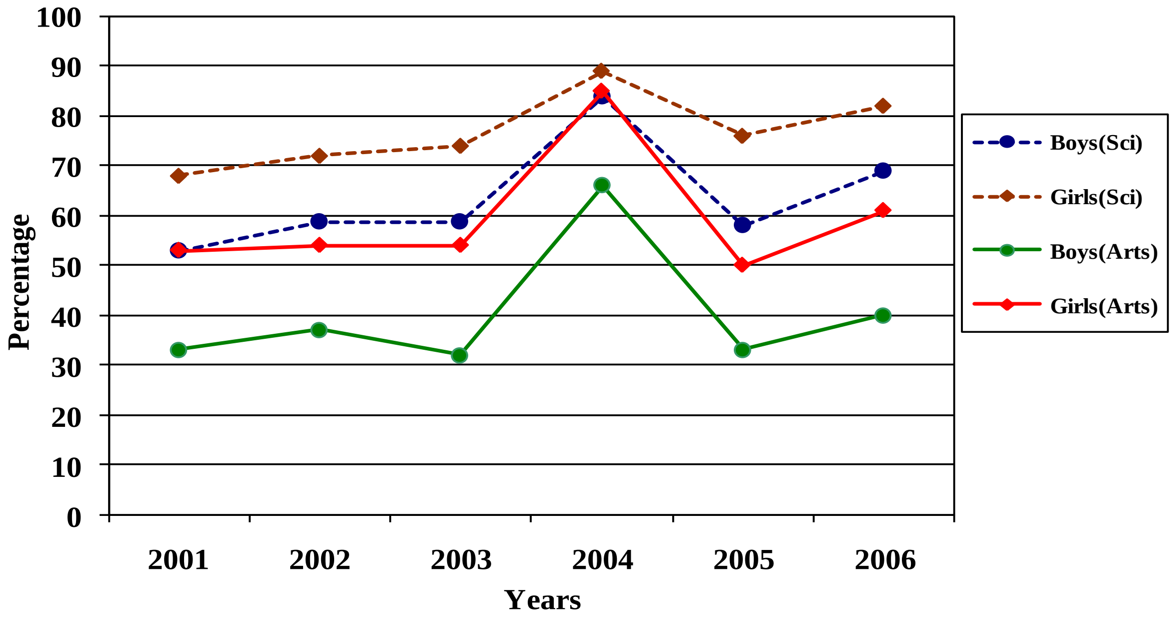

Figure 4.1. Gender Difference in Passing Rate 2004-06 in SSC exams in Pakistan

It is interesting to note that more girls than boys qualified in SSC examination, both in science and Arts groups. Two reflections can be deduced from the statistics and figure 4.1: firstly the rate of high passing percentage of girls is a clear reply to the negation of the stereotypic claims (Benbow & Stanley, 1980; Benbow et al., 2000) of incapability of females in mathematics and science. Secondly, the reflection of these findings demonstrates that girls are appeared as more committed in their studies and success in examinations than boys. A reason for these findings can be assumed that, girls, unconsciously or consciously, believe that they are allowed to get education not as their basic right rather a special privilege is given by their parents, on contrary, for boys, this is not the case. Instead they are expected to get education as their right, and in consequence, the feelings of over confidence or less sense of responsibility may develop due to the feeling that it is the duty of parents to accommodate them by any means. As it is observed that in Pakistani society, like other Asian societies, presence of a boy in a family adds to the prosperity of the family both socially and economically. But low participation of girls in science stream despite of their high passing rate is also a fact. Therefore, on the same pattern, to explore the situation of girls' participation in science, students' ratios in higher secondary school (HSSC) examination, collected data from different database sources are analyzed statistically in following part.

4.3 Gender Differences in participation and achievements in HSSC

To study the pattern of students' interest in different field of study at HSSC level, data were collected from databases of AEPAM and FBS and analyzed statistically according to the inscription of students in three main domains; Engineering, Medical, and General. In HSSC examinations, a relatively similar pattern of success rate preferring girls was observed. While, regarding the ratio of the boys and girls choosing a specific group of studies or a pre specialization, pattern was little bit different in HSSC as that of SSC. As mentioned earlier in previous chapter, that, education in science group divides into two fields of sciences or pre-professional education at higher secondary level: medical and engineering. Therefore, HSSC, the scheme of studies can be broadly subdivided into three groups that is, Arts[50], Engineering and Medical sciences. In 2006, total 49% of the boys and 51%[51] of the girls appeared in HSSC examination for Arts and humanities groups in all over the Pakistan, out of which, 66% of the girls against 48% of boys succeeded. In engineering group, total 102488 candidates appeared in exams, out of which, 84% were the boys and only 16% were the girls participated but comparatively 64% of the girls qualified in the examinations as compare to the 62% of the boys. Whereas in medical group, out of total 135746 students, 52% of the boys and 48% of the girls were appeared in HSSC examination and girls over passed the boys in success rate. The success rate for girls was 73%, while for boys it was 63%. These results demonstrate that, at HSSC level too, girls' passing ratio is more than those of boys in all three main fields of studies. Regarding inscription rate, participation of girls in Arts and Medical group of studies is quite equal to that of boys. However, in engineering group of studies, the situation is alarming regarding the girls' inscription. Data of ten years 1997-2006 were collected from the national database for Pakistan board of intermediate and secondary education and classified according to the three groups of studies. In Figure 4.2, a graph was drawn to present the picture of gender comparision in all groups of studies for seven years 2000-2006.

[50] This group includes all combinations (like Arts, social sciences humanities commerce etc.) of study groups except engineering and medical.

[51] Total candidates in this group were 534558 out of which 263273 were boys and 271285 were girls.

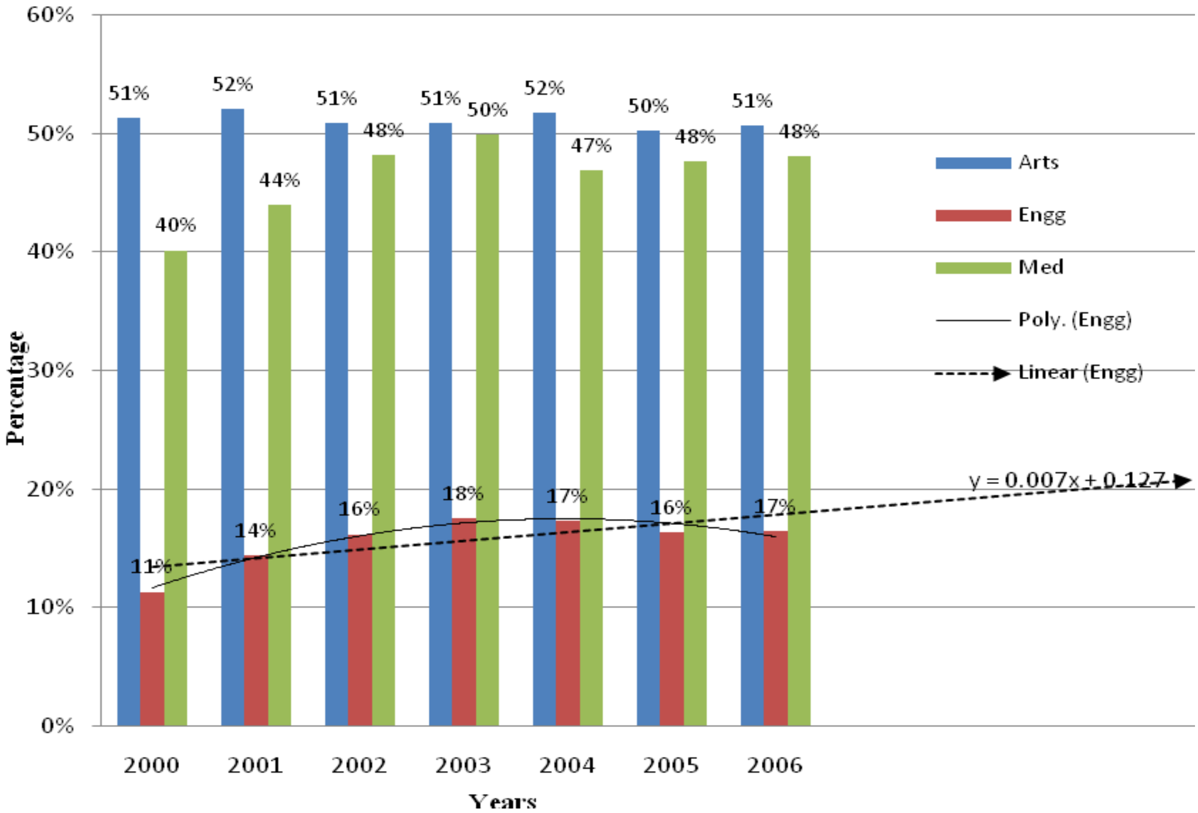

Figure 4.2. Percentage of Girls appeared in three groups of studies in HSSC

It can be observed in the graph presented in Figure 4.2, that, in Arts and Medical groups, gender equity has been obtained in terms of participation in HSSC examinations. However, in case of engineering, there were fewer girls than boys who adopted this field of studies. This fact indicates that girls were far less in numbers than boys who joined mathematics or technology related fields after their matriculation. If these statistics are compared with the previous ones in SSC given in Table 4.1, then it can be concluded that out of total girls, one third of which were appeared for science group in SSC examination, among them, 80% of the girls chose medical sciences, while, only 17% adopted engineering at the level of HSSC.

In 1997, only 7% of the girls appeared as compare to 93% of the boys in pre-engineering. This rate of girls' participation could elevate up only to 17% in ten years. This means that only 10% of girls' participation could rise up in ten years, that is, on average 1%

increment per year. This fact was also analyzed by fitting the straight line (Y=0.007X + 0.127) on the available data for years 1997 to 2006, mentioned in the graph 4.2, the expected ratio for girls' participation for the year 2010 is calculated at approximately 20% (Abbas & Kirch, 2010). Thus, on the bases of this analytical view of the situation, it can assumed that, if Pakistan continue with this pace and speed, further forty years will be required to achieve the gender equity at least in the participation rate in the mathematical sciences.

This situation provides the chunks of thought to explore that, why most of the girls do not continue mathematical sciences? This question leads us to study this phenomenon in terms of their inclinations and attitudes, which might have been influenced by the social environment. As the survey results of PSLM mentioned, earlier in this chapter, and findings that, girls demonstrated positive attitudes towards literature and life sciences, whereas, boys showed interest in mathematical sciences (Fennema, 1989; Parsons et al., 1982b; TIMSS 1999).

4.4 Research in Mathematics Education in Pakistan

In Pakistan very few research studies have been done in mathematics education, mostly conducted in the field of gender differences in mathematics achievement (Aijaz, 2001; Qureshi, 2003; Salfi & Saeed, 2007; Warwich & Jatoi, 1994). A series of studies were conducted under the administration of AEPAM with the collaboration of UNESCO from 2000 to 2006 to evaluate the primary education in Pakistan. The basic objective was to measure the learning achievements of the students from grade 1 to grade 5 in mathematics, Urdu language and science in all four provinces of Pakistan. Overall findings of these studies conducted for gender differences in mathematics indicated the better performance of girls from grade 1 to 4 but in grade 5 boys showed slightly better results (Boys =59 & Girls = 57) (Khan et al., 2007). However, the fourth study conducted in 2004, demonstrated no gender difference among fifth grade students of public schools but in private schools boys showed little increment. Boys attained 52% and girls attained 47% scores in mathematics. The findings of this series of studies[52] for Punjab revealed girls' better results in mathematics than boys. The interesting fact which is found in these studies that, there was no gender gap at 75th percentile of obtained marks among urban students, while girls in rural areas showed

52 Till 2006, five studies have been conducted at national level in primary schools of all provinces of Pakistan.

significantly better performance than their counterpart at the same percentile. These results somehow are strengthening the hypothesis of Fennema (1981) that, if girls are encouraged to participate in advance mathematics at the same rate that males did, then gender difference in mathematics achievements would disappear (p-10).

In the similar pattern, other studies done in Pakistan with the collaboration of DFID also confirmed more or less the same results at primary level (cf. Baseline Survey, Mirza & Hameed, 1994). But in the baseline survey (1999-2000) of grade 8 students reported the lower achievements of girls as compare to boys. Boys with mean score of 26.14% maintained their superiority over girls with mean score 23.17%. The scores of girls on items measuring knowledge were better than that of boys, whilst, in case of the items requiring comprehension and application of the concept, boys outscored girls (Mirza et al., 1999).

On the other hand, regarding students' mathematics achievement and influencing factors, Saeed et al. (2005) in a study analysed 1080 students (grade 3 to 5) of 36 primary schools with the collaboration of UNICEF. Researchers found a negative affect of father's occupation, father's education, and family size on the students' mathematics achievement. While the factors; mother's education, and socio-economic status, were found to have positive impact on the mathematics achievements of fifth grade students. These findings affirmed the strong influence of mother's education on student's maths achievement. This fact of strong influence of mother's education was observed in the findings of the PSLM survey, mentioned previously, from another angle (girls' low enrolment could be the consequence of mothers with no school education).

The reflection of these few studies, given above, is depicting the situation and direction of research in mathematics education in Pakistan. But so far as research in attitudes towards mathematics is concernd, how the social factors affect attitudes, and further, how gender differences develop in attitudes, much work has to be done yet in Pakistan regarding causal influence of social factors in the development of mathematics attitude. Therefore, the main aim of the present study was to make a small contribution in this dimension of the research. Next section, section three addresses the research problem and methodology of present study.

SECTION THREE: RESEARCH PROBLEM AND DESIGN

Chapter.5 Research Methodology

5.1 Introduction

Today we are living in more technologically complex society than before, therefore, every person usually needs essential functional knowledge of mathematics to comprehend the technological demands of the society (Gellert, 2001; Shoenfeld, 2004). Mathematics is no more merely a theoretical abstraction. Its practical and functional utilities are explicitly embedded in other physical and material sciences too. Within these sciences, it is strengthening extrapolations, and justifications of mechanisms or used descriptions of such phenomenon in highly sophisticated designs or ideas, which do not exist already. Whereas, in social and economical sides of life, we deals with mathematical operations and laws, implicitly in occupations and trade, hardly realizing its implications, manually or in the form of electronics devices, like; computers, mobiles and other variety of instruments. Without such implications, an economical system is hard to imagine. As Gellert et al. (2001) remarked;

> As a consequence of this development, it seems that the argument that more people need to learn more mathematics in a more successful way is based more on common sense than on rational reason or on justifiable evidence (p.58).

Therefore, in such a technology based era, mathematics literacy is not only a necessary requirement for daily life matters but also highly required for most of the prestigiously paid careers opportunities. It can be said thence that, expertise in mathematics is a necessary condition for important advancement in our society (Frenzel et al., 2010) because economical and social condition of a person and the society are concomitant. Highly technical and mathematical expertises in society bring technology revolution. This technology-enriched society then provides such environment to the people in which they are required to equip with mathematics knowledge to coop with the surroundings. These society members further participate and contribute in the society to maintain and to develop technically enriched environment. Thus, those people who fail to sustain are left behind economically and thence socially. As Shoenfeld (2004) remarked,

> Mathematical knowledge is a powerful vehicle for social access and social mobility. Hence lack of access to mathematics is a barrier--a barrier that leaves people socially and economically disenfranchised (p. 255).

Due to technology advancements in 21st century, every society recognized the ultimate importance of mathematics more than any other discipline in school curriculum. Therefore, in the education system, it is emphasized on empowering the new generation with versatile and powerful mathematical knowledge for economical prosperity of the nation. That is why, mathematics has generally been privileged subject in the school system and whose importance has been recognized that, in almost every country, no matter how different it is, in respect of culture, with possible dimensions of social preferences, economical position, and ideologies as compare to other countries, the similarities in mathematics curriculum can be found up to surprising level (Jahnke, 2002). Such universality approach of this discipline is also recognized in cross-cultural studies conducted in mathematics education. For example, IEA (1960)[53] studies in mathematics domain had conducted international surveys; FIMS[54] (1963), SIMS[55] (1977), and later a series of such studies conducted under the title of TIMSS[56] (1995, 1999, 2003 & 2007). More recently PISA[57] studies with the coordination of OECD[58] have been conducted across the boarders in numerous countries (43 countries in PISA 2000, 41 in PISA 2003 & 57 in PISA 2006). These series of studies presented a picture of international comparison, where, it also revealed the fact that, more or less, similar mathematical competencies from children are expected to attain at certain age levels all over the world (e.g., TIMSS consider the two age groups 9 years and 13 years with mathematical competencies in number, algebra, geometry, data handling & probability, whereas, PISA includes students of age 15 years). Therefore, the resultant outcomes of these mathematics trends were seen in the form of reforms and uniformity in mathematics curricula started in 60's (still goes on) and attention weas paid on meeting the international standards in mathematics education and raising their youth pool in mathematics.

On the parallel side of these international studies, in which mathematical competencies of student were measured and curriculum of mathematics id refined, there were other streams of research, which contributed in laying the foundation of mathematics education a discipline. Following is presented a brief view of research trends that were adopted and practised in previous few decades.

5.2 Research pattern in mathematics Education

Research in mathematics education is grounded at the nexus of the fields of psychology and philosophy, and mostly deals with teaching and learning as its two main

[53] IEA :International Association for Evaluation of Educational Achievement
[54] First International Mathematics Study
[55] Second International Mathematics Study
[56] Trends in International Mathematics and Science studies
[57] Programme for International Student Assessment
[58] Organisation for Economic Co-operation and Development

axis of investigation. The history of mathematics education as a discipline in not very old, though, its evolutionary growth is connected with pedagogy in 1900's. Later, in 1922 Thorndike work in psychology of Arithmetic, and L.L. Thurnstone's work in attitudes' measurement laid its bases in pedagogical and psychological research. However, it was established as an organized research field in 60's, when IEA and ICME[59] were appeared on the international scenario of research and education. Throughout its life span, different predominant theories of learning based on behaviourism, constructivism, cognitivism, socio-constructivism and then socio-cultural schools of thought, adopted from psychology and socio-psychology, contributed significantly to research in mathematics education in different eras. Objective of the present study is neither to discuss the justification of these paradigms shifts nor validation of their theoretical perspectives profoundly. Rather, in this chapter, a brief review of the research studies done in mathematics education is presented. For this, the contributions of Anglo-American (as their work was more cited) and French mathematics educationists (more cited in Francophone world) are focused to have an idea of its mode and basis, as there were many more theorists in other parts of the world who added tremendous knowledge in shaping mathematics education, for example, Steiner in Germany, Freudenthal in Netherlands, etc.

5.2.1 Anglo-American research pattern

In nineteenth century, during the decades of 1920's & 1930's, the theory of "drill & practise" based on the theme *extended repetitions as the vehicle for learning* practised in mathematics teaching in the perspective of behaviourism (Schoenfeld, 2002). In these two decades, a number of experiments were carried out to elaborate these methodologies and to examine students' learning, for example, in arithmetic (Thorndike, 1926; Clapp, 1926), multiplication (Noren& Knoght, 1930) and fractions (Brueckner & Kelly, 1930). Advancement in this paradigm was observed in post war era in 1950's and 1960's when a great emphasis on scientific progress was given and a shift towards scientific methods in mathematics and science education was observed. More notably, B.F. Skinner (1958) introduced *programmed instructions* with the notions of *mental structures* in mathematics teaching in shaping of behaviour of the student. This research theory greatly emphasized on experimental methodologies (with traditional experimental and controlled group designs), in which, the effect of individualized instruction through mechanical devices was used to observe on students in the form of response efficiency and performance behaviour. In mathematics education research, decades of 1970's is considered as a revolutionary era with

[59] International congress of mathematics education

the invention of computer and its implications in learning, which raised a new concept of *Artificial intelligence.* With the shift in paradigm towards cognitivism, where research in problem solving twisted to computer assisted learning, there, developmentalists added a considerable contribution in teaching and learning of mathematics by introducing the concept of intellectual development (Stanic, 1987). For instance, Piaget theorized developmental stages of thinking and proposed teaching of mathematical concepts according to child's cognitive development. In the light of this theory, further work was done in the pedagogy to teach complex mathematical concepts like, algebra, theorems, etc., at formal operational thought stage when child can deal with such mathematical concepts with logical reasoning. Later, educationists added the Vygotsky's notion of *culture* to set the foundations of social-constructivism approach in mathematics teaching and learning. The metaphors *metacognition* and *zone of proximal development* were elaborated and applied in mathematics learning process. Based on this paradigm of Piaget and Vygotsky approaches, research in mathematics education turned towards intervention programs. For example, in 1980's & 1990's in England, cognitive acceleration programs in science and later in mathematics for different age levels (through grade 1 to 8) were introduced. In the series of these intervention programs, it was delved that how student achieves his expected level of cognition in zone of proximal development through enhancing his thinking skills. These intervention-based practices were later followed by researchers in other Anglo-Saxon countries too.

In the brief historical view of research in mathematics education, we observed paradigm shifts from one school of thought to other; behaviourism to constructivism, the cognitivism to social-constructivism. Mostl part of the research was concentrated on teaching methodologies in the perspective of theories of psychology. Now to have other view offered by French researchers, following is presented a concised synthesis of research in "didactiques des mathématiques".

5.2.2 Research in "Didactique des mathématiques"

In France, this field of science is quite older than Anglo-Saxon world whose roots can be found in Rousseau's and Denis Diderot's philosophies of education. The in-depth discussion on these immense contributions and detailed analyses of research in mathematics education need another thesis to cover it, this chapter is focused, like above, very briefly the advancements in 20th century especially after the recognition of education (Les Sciences de l'éducation) as a discipline in French universities in 1967. As quoted by Guy Brousseau

(2000) "...Mathematics Education - taken as object of study - which grew out in the decade of 1960, complementary or alongside[60]..." (p.2).

In French system the term "Didactique des mathématiques" is used as equivalent to mathematics education in Anglo-Saxon. Sriraman & English (2010) described this term as,

> Didactic of mathematics is the study of the dissemination of mathematical knowledge, with more emphasis on the study of teaching...[It] also encompasses the study of the transformations produced on mathematical knowledge by those learning it in an institutional setting (p. 19).

Like mathematics education, didactic of mathematics is also a polyglot field and deals with epistemology, history, philosophy, sociology and psychology of mathematics. In 1960's, a prominent name, in this field of science, of Gaston Mialaret can be found on the horizon of French chapter. Gaston Mialaret, a mathematician and an educationist, was among the foundation fathers in the disciplinerization of 'education' in France. His work was mostly on experimental pedagogy. As in that era, more emphasis was given on teaching methodologies; therefore, he contributed a handsome work in teaching of mathematical concepts (l'enseignement des Mathématiques), which was aimed at fostering the conceptual clarity of students by focusing on developing mathematical algorithm in solving problem. Research in didactic of mathematics was boosted up in other dimensions too, with the creation of IREM[61] in Bordeaux.

Later in 1970's, another well-known mathematics educationist, Guy Brousseau proposed the Theory of Didactical Situation[62] (1970). This theory was focused on human interaction (teacher-student-content) milieu that helps in developing logical reasoning in the solution of the problem in given situation (cf. 'le cas de Gaël'[63]). Further, in this connection, Yves Chevallard (1999) offered the Anthropological theory of didactics (ATD) in the continuum of Brousseau's theory but in the wider setting that included cultural & social milieu also. As Artigue (2002) remarked that, Anthropological theory of didactics (ATD) is a socio-cultural approach that proposes mathematics as a product of human activity (cited in Sriraman & English, 2010).

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[60] L'enseignement des mathématiques - pris comme objet d'étude - qui s'est développé à partir des années 60 en complément ou parallèlement…

[61] Institute of research for mathematics education (Institut de recherche sur l'enseignement des mathématiques).

[62] La théorie des situations didactiques.

[63] The case of Gaël- the philosophy of situational learning was presented through the story of a 9 year old intelligent boy who particularly fails in mathematics.

Brousseau (2005) divided the format of 20th century French research in didactic of mathematics in two forms: *macrodidactique* and *microdidactique*. According to him, macrodidactique [in mathematics] deals with "partial or global functioning of aggregates of agents or institutions relative to the diffusion of aggregates of pieces of [mathematical] knowledge". Whereas microdidactique deals with individuality... "concerned with specific conditions which are at the disposal of a teaching organism to determine the appearance, appropriation and use of precise knowledge, perceptible in the behaviour of a human student organism". Therefore, agents like teacher & student in their characteristics and attitudes, are main focus of today's research (p.162).

This brief overview offers picture that research in mathematics education is centred on teaching methodologies and imparting of knowledge, which is aimed at gaining maximum success rate of students. Apart of the differences, the point is that, there are paradigms that shared affluent contribution to the research in mathematics education and remained influential in practice too. The common interest of these theories and practices concerned with student's performance, which was considered as the reflection of her or his mathematical abilities.

However, this brief overview also revealed that most of the attention was paid on the student's mathematical competency without considering her or him as an individual. Even when learning of the child was considered in the perspective of socio-cognitive development by offering *individual attention* slogan in 1980's & 1990's. In addition, Brousseau introduced microdidactique that dealt individuality, child was remained a passive object in the learning process. Education stakeholders like, teacher, researcher, policy makers, all viewed learner from their points of view, even in proposing her or his needs for successful learning environment. This objectivity of the learner even can be evidenced through educational policies and formed curricula. As Walls (2009) mentioned that, "children's accounts of learning mathematics are rarely included in public debate. The pervasive social lens, through which children's learning is figured, is an adult one" (p.3).

On contrary to the approach that took student as a passive object in learning process, there was another approach in the perspective of social psychology and feminists that addressed subjectivity of the learner. They presented another view of the causes of the problems during learning other than the intelligence, which directly links with the individual's personality, perception and social effects. This approach dealt peculiarly with all those elements and agents, though did not directly talk about the mathematics achievement, which participated in the learning infrastructure in order to provide the basis for affective learning of mathematics. Here, in the coming part, a brief review for this approach is presented.

5.2.3 Research in anxiety and attitudes towards mathematics

In 1960's, where the research in mathematics education was focused on the students' performance through effective teaching strategies, there were other fields of interest in research that addressed students' anxiety and attitudes towards mathematics. The possible thesis behind these two foci is that, sometimes or some students do not perform well even in the presence of well cooked teaching methodologies and other educational facilities. Why is it so? No doubt, there are individual differences and in which, differences in IQ[64] levels of students, is also an evident reason. However, few studies showed that as the situation or teacher-student relation was altered, a considerable change in students' performance was observed. The fact is obvious, that the change in situation cannot enhance or develop the IQ or intelligence of the students. Thus, question arises that, what change has happened that brings such outcomes? Theorists and researchers argued that in such phenomenon, through motivation or ease the students, their hesitation and anxiety, which often functions as hurdle in execution of possible efficiency, release. Hence, in result, their affectivity increases towards learning and performance. Therefore, recognizing this aspect in the procedure of learning, a twist came in research theme. The research paradigm in mathematics education; that was heavily relied on structured teaching methodologies and didactical experimentation to deliver mathematical concepts and in which, child was considered as an object in the educational process and his performance was taken more as predictable entity, shifted towards such paradigm that recognized, child as a subject, whose thoughts are of great account, and affectivity of learning in social perspectives.

Research in anxiety in mathematics dealt with two angles; test anxiety and anxiety in learning mathematics. Studies delved that threat in the result of past experiences related to poor performance or personality complex, is the main source of creating anxiety. Thus, an opposite relationship was found between performance and anxiety in mathematics. Being a cognitive process, anxiety is more situational that may accelerate with the change in situation. Therefore, through such investigations in mathematics anxiety, a turning point in the direction of research from structured teaching methodologies approach to metacognition and situated learning practices could happen.

[64] Intelligence Quotient

On the other hand, studies, in attitude towards mathematics, explored student's perceptions a step ahead. As it is explained previously, that attitude is relatively more permanent in nature than anxiety, and therefore, certain change in situation does not affect attitudes to a great extent. Research, in this construct, dealt with investigating the relation between mathematics achievement and attitude towards this discipline and concluded a positive relationship between them, though the direction of influence is still a debate. Studies in mathematics attitudes mostly focused on the subject of gender differences and provided a thesis in social perspective against biological approach that claimed females as mentally inferior to males by birth (c.f. Benbow & Stanley, 1980). Thus, a feminist movement, for encouraging girls' participation in mathematics and related career, was waved that did not deny the claims against girls only, but also changed the scenario of the research. Feminist movement provided other grounds of cultural constraints and societal hurdles in the explanations of such differences, if there were so.

This paradigm of research in mathematics education, in the context of social psychology, on the one side, compelled theorists to modify their contexts whether it was about the subjectivity of the child or based on gender discriminations. On the other side, it helped the researchers to discover a relatively balance reality by taking in account the culture, society and stereotypes. Therefore, in this context, the present study proposed to explore the developmental process of mathematics attitude under the influence of social agents through the lens of the subjectivity of the student.

5.3 Rationale of the study

This study considers student or learner as the source of having feedback of the measures taken to enhance learning. Thus, the quality of any research study that deals with learning process becomes questionable, if it does not take in account learner's own intentions towards learning. This intention of the student is not conditioned with educational resources (that includes material and physical both resources) only, her or his emotions, and inclinations are the significant facts as well, which work not less than the catalysts in learning process. Student's own reflections as a result of her or his experiences with teacher, parents, peers, social milieu, etc, leads to emergence of her or his feelings, perception that ultimately let her or him decide what and how she or he should do, because, learning mathematics is not mere getting information. Skovsmose (2005) stipulated that "a learner can learn many things by command, but if learning means not just receiving information but also includes reflection and a critical awareness, [then] the learning has to be performed by learner" (p.91). Therefore, student's inclination towards learning has its unique importance. If a student is not inclined towards or ease with mathematics, then no matter how controlled and scientific a teaching methodology a teacher adopts, process of affective learning in mathematics will not only slows down, but also, there'll be flaws in the concept formations which may regenerate more negative feelings about mathematics.

This theme, as mentioned above, which Brousseau named as *microdidactique,* and which, on the other hand, is quite consistent with Foucault's notion of subject (*the student participating in mathematics as social and intersubjective being*[65]), in which child's subjectivity is constructed by social practices and embedded in relation with them. Therefore, this study was focused on exploring the cause and effect relation according to student's perceptions about social factors to analyse her or his mathematics attitude rather than the direct perceptions of parents and teachers. The subjectivity of the student is addressed in order to explore her or his engagement with mathematics in the form of attitudes towards its learning, as Foucault perceived *a self* as *a subject* in a society in terms of power/knowledge (*pouvoir/savoir*) relationship (Foucault, 1984). Child comes in mathematics classroom with her or his self, inscribed in subjectivities of beliefs and confidence etc. These subjectivities of the student, which are based on her or his experiences in the society, including relationship with family, friends, culture & environment, are taken as her or his background by mathematics teacher in order to formulate her or his certain expectations and ability beliefs about the student. This study was, therefore, also focused to explore the phenomenon of student's experiences in the mathematics class in relation with teacher's behaviour and mathematics performance that perpetuate her or his subjectivity in terms of her or his mathematics self-efficacy and self-concept. These mathematics self-beliefs further construct interest and belief of utility and value in mathematics as two components of mathematics attitude, in the light of student's background factors, like; gender, SES, family environment etc.

5.4 Research Questions

In the light of previous discussion and extensive literature review, present study contemplated all those necessary processes, which influence the perceptions of a child in order to develop attitude towards learning mathematics, in the presence of his personal characteristics and further social characteristics and stereotypes. Therefore, there are two main axes of the investigation in the context of Pakistan. First axis dealt with the differences

[65] Walls, F (2009, p.265)

among the students in their mathematics attitudes regarding their gender, age, and further according to their socio-economic status. Second axis of present research is focused to explore the causal relationships of sequential ordering among the social factors (teacher and parents) and student's mathematics self-beliefs in the formation of attitude towards mathematics.

In the cadre of differences among the students, research studies (Blondin & Lafontaine, 2005; Hyde et al. 1990; Li, 2004; TIMSS, 1999) examined gender differences in mathematics attitude and quoted significant positive mathematics attitude in favor of boys. Present research tried to explore this issue further in components and dimensions form. Therefore, concerning the first axis of the research, the main question of current investigation is :

Do girls and boys, in Pakistan's schools, differ in their attitudes towards mathematics?

If yes then, does this situation exist in both components? Or, too narrowly, does this difference persists in certain dimensions of mathematics attitude?

Research studies also indicated that students in higher grades demonstrate less positive attitude towards mathematics than the students in primary grades (Ma & Kishor, 1997; TIMSS, 1999). Therefore, this study is also intended to examine the effect of age in the context of pakistan, that is,

Is age a moderating agent in the formation of students' attitude towards learning mathematics?

If it is so, then, with the passage of time, in which dimensions [of mathematics attitude], such changes occur?

Moreover,

Do age and gender interact significantly in the development of mathematics attitude?

In addition, what changes happen in the perceptions of boys and girls in mathematics attitude formation process with age? Or,

Do girls and boys show similar variation in their mathematics attitudes across the age?

And lastly, under the same axis, the influence of socio-economic status, which may alter the achievement and attitude pattern, appeared a major factor in research. Therefore, to study the influence of parents' education level and profession on the pakistani students, this study has inquired that,

Do parents' socio-economic status, in terms of their education level and nature of profession, play a significant role in developing student's positive belief about the need of mathematics?

If yes, then, does this attitude formation s different for boys and girls ? Further, at which age period this effect is more significant?

The second axis of the investigation is based on the testing and validation of the theoretical model of the formation of mathematics attitude, given in second chapter, thus raises the main research question of the present study,

Do the causal relations among the student's perceptions of social variables (parents and teacher) and student's mathematics self-belief variables significantly contribute in the formations of attitude towards learning mathematics?

To examine this formation process of mathematics attitudes under this main question, further sub questions arise. It is pertinent to study that,

Do mathematics belief and interest as the constructs of mathematics attitudes communicate with mathematics self-efficacy and mathematics self-concepts of students?

In addition, research indicates that parents, as powerful background factor, are of critical importance for student's learning outcomes in mathematics. But how it comes? To determine this in the connection with mathematics belief or mathematics interest, study has examined that,

Do parents' socio-economic status, help, and encouragement have direct causal effect on the development of mathematics belief?

This dynamic interaction between these initial attitudes and integrally related in-home variables may appear as perpetual expectation of future career with which student enters in the mathematics class. But this interaction highly depends on the students' experiences with mathematics teacher that influence students' expectations for future performance. Therefore, in the classroom context, what causal effect, direct or indirect, do the perceptions of students about teacher's pedagogy, behaviour and encouragement have on the development of their mathematics attitude?

Moreover, as the components of mathematics attitude, what causal order do the mathematics interest and mathematics belief possess?

It is also evident that as the member of some particular society and following particular culture with some stereotypic views, no doubt influence one's self-perceptions, expectations and decisions. This fact poses a question on parents and teacher's stereotypic views that bring them to expect differently from a boy or a girl. Such question is inquired in the current study that is investigated under the following question.

Do stereotypic beliefs influence this causal relationship among the factors of social agents and student's variables? If so, then, does the direction of causal relationships (as hypothesized in study) differ with respect to the gender differences?

On the other hand, in literature review, it was observed that parents and teachers deal girls and boys differently. Therefore, in this research, further investigation is,

Do causal effect of boys' and girls' perceptions of teacher and parents differ in the development of mathematics attitude? That is, is gender a moderator for the causal relationships in the proposed model?

5.5 Problem statement

The formation process of Mathematics attitude, in the form of dimensions representing cognitive and affective polls, depends on experiences that a student encounters in this discipline under the influence of his perception of social agents and his self-beliefs. In accordance with stereotype that, *Mathematics is a male domain; mathematics is dry and complex and males are confident and intelligent*, it is used to expect that males should show appreciation of mathematics. In addition, choice of this discipline proclaims generally gender differences. As girls choose less mathematics and engineering stream of studies and fewer women than men excelled in these careers, therefore, on the base of this distinction, usually females are percieved less competent as compare to males to precede these disciplines. But these myths and proclaims usually ignore social process of upbringing a child under the influence of set gender roles' mythologies which permeates male as competent and female as fragile. Present study addresses the effect of this myth in the formation of mathematics attitude and investigates that student's attitude towards mathematics (in the form of dimensions) and its learning, is nor an independent process neither it is the output of mathematics intelligence only. Rather, it is, as an evaluative judgement, develops in accordance with personal satisfaction or need which generates under the influence of the behaviour of the role models and relation with them: parents at home and teachers in the classroom. Gender stereotype, culturally defined gender roles especially in Pakistani context, and socio-economic status permeate the social agents to develop their perceptions about students' abilities and capacities. With these perceptions, they expect and exhibit their behaviours accordingly, and indirectly inculcate their expectations in the student. Therefore, this pervasive effect of the social agents, when a student views through her or his personal lens, develops the perceptions about her or his mathematical competencies differently. These mathematics self-beliefs, in the light of personal satisfaction or need, permeate a student in developing her or his mathematics attitude in the particular dimension, which affects the continuation of this discipline later for future career too.

5.6 Objectives of the study

The purpose of this study is to examine the mechanism of attitudes formation of students from grade 6 and 9 towards mathematics and learning in it. Mathematics attitude, which is the combination of cognitive and affective components, has long been the debate in research in mathematics education. A rich scholarship on the measurement of mathematics attitudes in different perspective can be found in research but without proposing well-defined conception or sometimes no definition of this term. Therefore, the primary aim of this study was to elaborate theoretical framework of mathematics attitude and proposed a comprehensive definition of it.

Further, major aim of this research is to propose a theoretical model in order to understand conceptual framework of mathematics attitude and the process of its formation, in which, the relationship between students' self beliefs in mathematics and their perception of their parents' and teacher's dealing with them were examined.

In addition, students' personal characteristics (i.e., gender, age, SES, adult's help in mathematics learning, etc.) and self-report data about their perceptions of different parents' & teacher's related variables were aimed to measure in order to analyze the causal relationships among these factors and to measure mathematics attitudes. Sicnce very little work has done in this cadre in the context of Pakistan, therefore, a research instrument that can be valid and reliable for Pakistani students was required. Thus, more precisely, the objectives of the study in this cadre were,

- To develop instruments of the study to measure the mathematics attitudes of students of age 10-11 and 13-14 years.
- To construct the parents' scale to observe the children's perception of their parents' influence.
- To develop the instrument to measure the students' perception of their mathematics teacher's effect.
- To construct an instrument to measure the students' mathematics self-efficacy and self-concept.
- To derive a scale to examine the student's perceptions about stereotypic beliefs in mathematics.

Further objectives of this study, in respect of exploring valid causal models of attitudes development in mathematics, in the perspective of gender, SES, age differences etc., are,

- To explore how parents' and teacher's variables orient student's interest in, and belief of, mathematics.
- To examine the differences in causal model of mathematics attitudes formation in the perspective of gender.
- To analyze how different social perspectives based on socio-economic status can communicate mathematics beliefs to students.

5.7 Significance of the Study

It is an established fact that dignity and economical prosperity of a country go hand-in-hand which depends on the educated nation. Technical and skillful labour in any country is the most valuable resource to achieve and to maintain the prosperity in a country. And to have such nation, school in any society is that valuable production unit, through which, one generation imparts its cultural norms and necessary skills to the next generation in order to contribute according to the needs of the society. Therefore, those nations who are considered to be role models for the world, recognizing this significance, education preferences, policies, curriculum development and teachers' trainings etc, set in order to have such population which should be technically equipped and assures economic progress and hence the dignity of the country. Its worth even multiplies when there is a developing country like Pakistan, struggling for better position in the world, where scientific and technically trained people can function as the backbone of the economy.

Study of attitudes is an important domain. Research literature reports that change in attitude towards mathematical sciences in 19^{th} century brought enormous scientific revolution in today's world. Therefore, to bring developing country, like; Pakistan, into the stream of development to meet 21st century's requirements, it is an ultimate necessity to make every possible effort to alleviate the shortage of scientific and technical skilful personals and upgrade research facilities and opportunities. To ensure this stream of development, it is necessary that education facilities should be provided to every child and further, students' positive attitudes should be developed towards mathematics and Science in school to convince youth as much as possible towards engineering and technology. Therefore, this study will be beneficial for the policy makers and curriculum designers in order to revise and modernize mathematics curriculum based on creative, meaningful and practical relevance that attracts student's interest and consequently will raise the number of students in mathematical sciences.

In addition, this study, based on socio-cognitive domain, explores the relationship of teachers and parents' help, attitudes, behaviours etc., in the development of students' attitudes towards mathematics. Therefore, results of this research will discover the influencing variables that will help us to understand the mechanism of developmental trajectories of mathematics beliefs, interest and values of students at different age levels, and moreover, according to gender. Due to indication of such factors, parents and teachers will have reflections to ameliorate their dealings with students that are often observed very authoritative and stereotypic. Especially for girls, who are 50% population of Pakistan, the outcomes of this research will contribute in exploring the reason behind the underrepresentation of girls in this domain in spite of having better achievements. Hence, it will conducive to encourage girls in mathematics and engineering fields whose participation rate at present is only 16% as compare to boys. By increasing girls' participation in post-compulsory mathematics (which is a challenge for mathematics educators and policy makers), Pakistan will be able to use her full pool of talent resources in a better way, which will help in strengthening the economy of the country.

Furthermore, present study will contribute to the theoretical conception of mathematics attitude that lacks in this cadre and needs to be worked more. In addition, this study will serve as a significant addition to the research in mathematics education too as it is noticed in literature review, that very few studies in the domain of mathematics attitudes have been done in Pakistan, no such notable work has been done yet. Therefore, where this study will open a new door in research in mathematics education in the context of Pakistan, there it will also provide another angle to look mathematics teaching to abate from transferring bookish knowledge and conventional teaching methodology based on formulae memorization and problem solving practices, towards the practical relevance of the mathematical concepts and thinking enhanced methodologies, which will develop positive attitudes in students towards learning this discipline. Consequently, an addition of valuable knowledge to prevailed mathematics teachers' training programs and refresher courses may also be possible. In this way, the ever-worst condition of mathematics in Pakistan can provide a chance to reorganize and strengthen.

Last but not least, this research will also provide chunks of thought to students in order to figure out reasons for their low achievements and negative attitudes towards mathematics. Hence, they themselves may have an opportunity to think about their intellectual development and flourish their mental abilities, which, in results, will enhance their self-concept and confidence in their competencies to do mathematics, and thus, positive attitudes towards learning mathematics. Further, schools and professional institutions can use the scales of this research for future study and as an intention assessment tools to make the better decision and guide students according to their intentions at early stages to bring them into a useful asset of the country.

5.8 Limitations of the Study

This study is concerned with the effect of the perceptions of Pakistani students about their teachers and parents in the development of their attitudes towards mathematics. Therefore, it has several limitations. Cross cultural studies depict that instrument for measuring psychological and social traits in one culture may not be valid fully in other culture where norms and values are defined in quite different scenario. Therefore, to develop such instrument that can be valid for Pakistani society, this study is limited to consider those characteristics and perceptions that are prevailed in the Pakistani society especially in province Punjab.

Further, the final instrument of this study is conducted in two districts of Punjab due to several reasons, along with time and resources constraints, thus limited to these conditions. Average literacy rate of Pakistan is not the true representative of whole population as it does not truly represents the literacy rate of all provinces, as well as within a province, there is great dispersion among the districts' literacy rate. In Punjab, compare to other provinces, this dispersion is less, and the two selected districts for the current study represent the group of above average literacy rate of this province. Therefore, this study may be valid to those districts where the average literacy rate is approximately 50%. In addition, this study is limited to public and private schools in urban areas only as girls' proportion in schools is better in these areas.

In addition, this study is limited to sample from two age groups only, i.e., 10-11 and 14-15 years, to observe the mechanism of trajectories of mathematics beliefs, interest, and self-perception beliefs. As research literature review indicates that gender differences in attitudes and achievements in mathematics usually appear from age 10-11, which later become significant from age 14.

This study is aimed at exploring the effect of teachers' methodology, encouragement and classroom behaviours etc., and parents' help, expectations, and gender beliefs on students' mathematics attitudes. These affects are measured from the students' perspective through the instrument, which provides self-report data rather than teachers' and parents' direct self-report data. Therefore, we are limited to those specific aspects of above-mentioned factors that students feel to have causal relationship with their self-beliefs in mathematics. Hence, these effects and relationships are studied according to the predefined premises of variables, which are given in the form of operational definitions in Appendix 1.

5.9 Assumptions

Present study assumes that students' attitudes towards mathematics in the form of declarative statements can be documented through self-report data. Research instrument of this study is assumed to translate the feelings and conceptions of the students about mathematics and their competencies in it, and their perceptions of parents' and teachers' attitudes towards them. Therefore, it is assumed that students of both sixth and ninth grades will respond the research questionnaire of the study honestly and according to their perceptions to maximum possible extent what they have about others and of themselves.

Furthermore, it is assumed that the research data provided by the sample of the study will examine the model of causal relations among the factors and with students' beliefs and interest in mathematics.

Key Terms

Our study deals with different key terms to explore the research problem. Therefore, it is necessary to define these terms operationally to declare the premises of the research in order to avoid the ambiguities. Key terms of important variables of present study are given in Appendix 1.

Chapter.6 Research Methodology

6.1 Introduction

Present study is investigating mathematics attitudes of Pakistani students and influence of social factors in the development of attitudes towards learning of mathematics at two age groups levels. It is widely argued that quality of research study depends on relevant information. Therefore, an instrument that addresses factors, styles and language, which prevails in a particular culture, can assure to provide required data that can approach the problem truly. Therefore, development of an instrument that can measure Pakistani students' mathematics attitudes and effect of social factors in the formation of these attitudes was direly needed for the present investigation. This study has two major tiers in the research part. First level deals with the development of appropriate scales to measure the attitudes of the students towards mathematics, their perception about influence of other social agents and their self-beliefs. Second level addresses the analysis of causal relationships among the variables and verification of the hypothetical model through the data collected from these scales. As both tiers have their particular and distinct objectives, thus, both need their respective research methodologies and designs, which are explained in details in next section.

Current chapter of this section is offered a brief but comprehensive overview of overall research procedure and issues in the conduction of present study from preliminary survey to final administration of research instrument

6.2 Research Methodology

A Non-experimental quantitative research is different from experimental research because variables are not manipulated like in experimental study, rather they are studied as they are in their original state. Therefore, this type of approach is most suitable and frequently used in social sciences where variables are generally attributed with certain characteristics like, gender, beliefs, socio-economic status, interests, attitudes etc. In addition, this approach is suitable where ideal experimentation is not practically possible to realize in social settings (Pourtois & Desmet, 1997). For example, in experimental studies, before manipulating independent variables, researcher selects sample of the study, randomly or using any other technique, and then divides them into groups for observing cause and effect relationship in any treatment or intervention.

Whereas, in non-experimental methodology, variables such as, students' socio-economic status or IQ levels, etc, are naturally existing attributes, thus can't be fully manipulated. Or, sometimes in social sciences, like social psychology, researcher wants to observe students' perceptions, beliefs etc, in the light of their respective milieu and social setup with which they belong to. In both cases, any manipulation is of no use or unethical, therefore, we need to deal with attributes in their original settings. Moreover, sample can't be selected randomly, hence a non-experimental methodology is needed to adopt for such situation.

There are two methodologies that are commonly used in the cadre of non-experimental research, correlational research and survey research. Some researchers used other labels with slight differences, for example; causal-comparative, descriptive, predictive, explanatory, cross-sectional research methods, etc. (Cohen et al., 2007 & 2005; Muijs, 2004; Pourtois & Desmet, 1997; Wiersma, 1995). Present study is based on non-experimental research design in which at first stage, qualitative methodology was adopted, and later quantitative research methodology was used. At the first stage of construction of research instrument, to collect the relevant information, a qualitative preliminary survey was conducted in postgraduate institutes. To gather preliminary data of the influencing factors on the mathematics attitudes, a questionnaire based on open-ended questions and checklist, was used in this survey. This data was categorized and processed in order to develop items of the attitude and social factors' perception scales. At the next stage, under the non-experimental design, a quantitative survey method was adopted, primarily for testing the developed instrument in pilot survey, and later, for measuring the relationship among the variables, representing social factors and self-beliefs of students, and their effects on students' beliefs and interests in mathematics.

6.3 Survey is suitable strategy to measure attitudes

It is generally argued that survey method is the most efficient way to collect the relevant information from a big mass of target population. Further, it gathers data in *one-shot* basis, therefore, it is economical and time saving too. Moreover, in non-experimental research, where researcher wants to study variables in their "natural settings" within social constraints, survey is considered as best option to collect data.

According to Cohen et al., (2007), Survey is to, " to gather data at a particular point in time with the intention of describing the nature of existing conditions, or identifying standards against which existing conditions can be compared, or determining the relationships that exist between specific events" (p.205). Due to this nature, surveys can be used just for simple purpose of description of sample's characteristics, in terms of frequency graphs or descriptive statistics, and for highly complex relationship analysis of variables.

Survey serves as most commonly used self-report method and its scope is quite wide. On one side, it is suitable in such conditions in which, people hesitate to speak because of social or personal constraints. Questionnaire, based on closed end questions or check items, becomes a better source of obtaining data instead of interviews or any other method. On the other side, its scope can be seen in contemporary study on mathematics intelligence or attitudes across the borders and cultures that might cover dozens of countries. Survey method gathers data in one-shot, for example; TIMSS studies that held in more than 40 countries further, and PISA which is conducted in more than 50 countries, follows survey methodology.

In present study, survey methodology (semi-qualitative and quantitative) is adopted due to its vast application and benefits in the sense that it is suitable strategy for gathering relevant information from Pakistani students. In the first stage of the research, exploratory survey was adopted in Pakistani universities in order to explore patterns of variables, which serve as the catalyst or hurdles in the formations of students' positive attitudes towards learning mathematics, for developing the measurement scales. In the stage afterwards, survey method in the confirmatory sense is adopted in Pakistani schools with the aim to analyze the causal relationships in hypothesized model. Details of these surveys and development procedure of the instrument are discussed in next section.

6.4 Research design

Research design is usually called as a plan or strategy for conducting the research (Wiersma, 1995). A good research design elaborates the procedure of selecting best suitable sample for obtaining relevant information and research process for data collection & analysis in order to address research questions of the study. As explained above, this study is aimed to accomplish two major tasks; that is, developing the research instrument and collecting data for analysing research questions, which include both qualitative and quantitative research methods. Therefore, an elaborative and sequential design, that explains each stage throughout in the instrument development and data collection process, is developed in figure 6.1. In this design, different processes for collecting qualitative and quantitative data, and developing instruments at different stages throughout the data collection process, are presented in rectangular boxes. Software selections and getting permission to conduct surveys during data collection processes are represented by dotted square structure, whereas, arrows represent the sequence and directions between the processes during the whole design.

The pivotal factor of data collection process in any research design is time and resources: material and human. Therefore, particular time span was allotted to each stage and process to complete the research in due time frame. Further all available resources were systematically planned to achieve the required outcomes in given time. This task was decided in the start of the research study, mentioned in the flowchart in the figure 6.1.

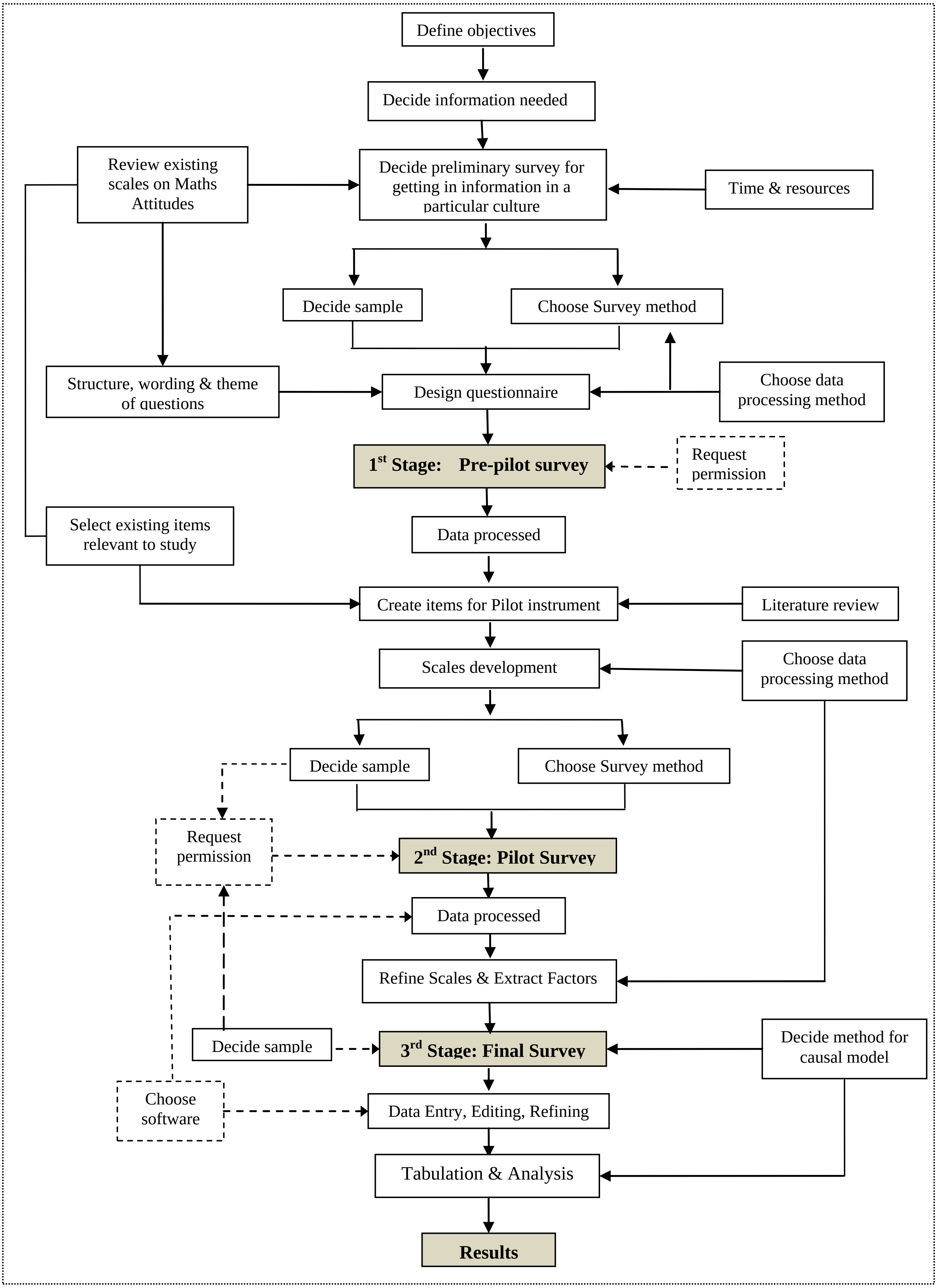

Figure 6.1. Stages for instruments development and data collection process

6.5 Data collection process

The research design of the present study that starts from the research objective of exploring the influence of social factor on students' mathematics attitudes, and ends at the results, is divided in to three major sections shown in Figure 6.1. Each stage in the data collection process, depending on previous stage and extending to next, aims at obtaining a way between what is to be done and how it is to be done. The first and foremost part of this design is a pre-pilot or preliminary survey to develop the instrument of the study. Further, stage deals with instrument refinement, and then lastly, final data collection process, in order to achieve the objectives of the study. Each stage of present research study is briefly explained below to have an idea of detailed exploration, done in next section.

Pre-instrument survey

To develop an instrument, it is important to gather the relevant information about the variables of the study on which a research problem is based. Therefore, a pre-pilot or preliminary survey was conducted before the pilot survey. As the main aim of a pre-pilot survey is to collect preliminary information about the variables of the research, therefore, it usually consists of open-ended questions that are used to generate the categories (Cohen et al., 2007). In current study too, a questionnaire containing open-ended questions is developed, thus, this stage is qualitative and exploratory in nature. Through this questionnaire, data is collected on the influencing factors on the development of the mathematics attitudes of the students. On parallel, literature of research studies, and already developed mathematics attitudes instruments, were reviewed to gather information about the factors and selecting the relevant items.

The sample of graduate students, specialization in mathematics, was required for this survey. Therefore, heads of the mathematics departments were contacted in order to get permission and confirmed the schedule to conduct the pre-pilot questionnaire in different institutes. The data of this preliminary survey was processed and analysed in order to determine the categories of factors. In the light of literature review, the wording and theme of the items for the instrument were organised. In the developed instrument, it was ensured through validity process, that all items present in the instrument should represent specific objectives of the present study. Further, it was assured that the premises of all objectives have been covered within this instrument before conducting the pilot testing of the developed measurement scales.

Pilot-instrument survey

The next stage of the research process was to conduct pilot testing of developed scales. Present research problem is to explore the influence of different factors in the formation of mathematics attitudes with respect to the trajectories of the age, gender and socio-economic status etc. Therefore, the next obligatory step was to select the sample of the pilot study as mentioned in “Decide sample” block in the flowchart in Figure 6.1. Students of two age groups, from different schools of three districts, were selected according to the requirement of our research and pilot-test was conducted.

The next important phase of this stage is the choice of data process method and suitable software for statistical analyses. As this phase is aiming at refining the instrument and further extracting the factors out of these scales, therefore, by using SPSS, reliability of the items in the scales was calculated. Those items were dropped or rephrased from the scales whose reliability values were below the standard value. Later, factors were extracted of each scale through exploratory factor analysis process. As it can be seen in the figure 6.1, the final instrument of the study at this stage was prepared for final survey.

Final instrument administration survey

The second main objective of the final survey was different from the objectives of previous surveys. Formerly, other surveys were aimed at developing the instrument but in final survey, the data were collected to investigate the research questions and the causal models, therefore, arrows at the first in the figure are also not showing any relation with previous data process stage.

At the first step of this stage, target population and sample of the study were decided and to precede further, permission from the schools were requested. The final instrument was conducted in different schools in final survey and data were collected. Later, by using SPSS and AMOS, refined data were analysed to obtain the results for the research questions.

In the research design, other necessary and complementary procedure were getting approval from different concerning authorities, and ethical issues during administration of research project, which are given below.

6.6 Approval for conducting research

Research procedure is not merely a collection and analysis of data, and interpreting some results. There are several mechanisms by which, a researcher passes to arrive at the step of data collection. The core step in fieldwork and surveys is to get approval from governing bodies and permissions from departments where survey is to be conducted. In present study, prior to data collection process, researcher was required to go through the process of approval, which was, in this study, mainly divided in three stages. At first stage, approval from home department of the university and funding organization and later, permission from universities, especially heads of the departments for conducting preliminary survey were required. In the end, administratively, the permission was sought from the principals of the sample schools, and education department (if needed) in different districts of Punjab, details are given below.

Home department approval

First and the foremost step to start research process was to obtain the permission from the home department (Faculty of Education) or doctoral school of Université de Strasbourg (UdS), to collect the research data. Here in home university, it is practice that project director is the authority to allow doctoral student to conduct research survey. Therefore, on the bases of continuous and satisfactory progress report of the researcher, project director approved the stage of data collection process. As this study was concerned with surveys in different institutions, including schools and universities of different districts of Punjab to collect data, therefore, an approval letter showing the research subject and purpose of study was required. Research director issued this letter to the researcher in order to precede the request to the Heads of departments, principals and headmasters/mistresses of schools to conduct surveys in their institutes.

The next step was to inform HEC[66] for an ethical approval to conduct the research in Pakistan, because the process of whole fieldwork was about three to four months. Therefore, a letter was sent along with copy of approval letter of research director and air tickets to concerning person in HEC mentioning the objective and dates of stay in Pakistan.

[66] Higher Education Commission, Islamabad. Pakistan. Present doctoral project was funded by HEC.

Getting permission from Pakistani institutes to conduct surveys

To achieve the set of goals of research project within allotted time and resources greatly depends on the availability of data that further lies on the access to subjects of the study. To have this access for the required sample of the study, a researcher should have the knowledge about the administrative bodies and proper channel to approach them, through which she may have permission to conduct the surveys in selected institutes.

In present study, at first stage of the development of the research instrument, a preliminary survey was needed to conduct on postgraduate students of colleges and universities to know their views and perceptions about mathematics and reasons to adopt mathematics in their higher studies. In order to achieve this goal, researcher contacted the heads of mathematics departments of two post-graduate colleges and two universities in Lahore for having their permission (one college was dropped due to semester examination then). No matter how much we believe and adopt formal way of doing things, personal contacts have their own place that can't be denied especially in fieldwork. Therefore, through the help of colleague friends working in these institutes, researcher met heads of the departments of these institutes. In her meeting, researcher explained her purpose of meeting and presented a brief research proposal mentioning the research objectives and purpose of data collection along with the approval letter of research director and researcher's own student identity card. With their personal interest in research project and kind permission, dates were set according to the availability of the students.

After gone through this step of data collection and development of instrument for study, the next step was to contact schools for conducting pilot study on school students. Initially for pilot study, researcher contacted five schools from three districts (Islamabad, Lahore and Sargodha) of Punjab. Principals of four schools allowed to conduct pilot survey and communicated their available dates to the researcher. As research instrument was in two parts and moreover, it was focused to study students from two age groups, so on average, four visits were paid in each school.

At the third and last stage of administration of final instrument, two districts were chosen (Lahore & Sargodha, dropping Islamabad; details are given in next chapter). Total seven schools from Sargodha and three schools from Lahore among the total schools contacted allowed us to conduct the survey in their schools

6.7 Ethical issues during survey

Ethics in research has a predominant value especially in the field of social sciences. There can be a long list of codes of conducts including ethical codes that a researcher needs to take in account and being a researcher never lost sight on the obligations of the subjects of study. Cohen et al. (2007) emphasized that, “at all times, the welfare of subjects should be kept in mind, even if it involves compromising the impact of the research” (p.59).

In current research, a special care was taken in this matter, at any place during survey or on the questionnaires, identities of the subjects were not asked. Instead, temporary and distinct identity number was written on each questionnaire that was required to be remembered by the subject because she or he was required to participate twice in the study. Further, special considerations were taken that students should have free will to participate in the survey. Therefore, researcher always, even having permission from heads of the schools and concerning teachers, asked the students if they were willing to spend some 30 minutes to fill up the questionnaire. Even during survey if any student didn’t want to continue she or he was free to quit.

Furthermore, to make students relax and agreed for participation in the survey, students were assured the confidentiality of their responses and it was made clear that their responses will not be exposed to their teachers or principals or any other person after the survey. As this study is included a teacher scale too, therefore, a sense of hesitation was expected from students. To release such hesitation of the students, class teachers especially mathematics teachers were requested personally to avoid entering in the class during the questionnaire filling session. After every session, the sheets used to put into envelop and sealed up in front of the students, in some cases, some students themselves accompanied the researcher till the gate of the school to see her off.

In addition, with every questionnaire, a written note explaining the brief description of research objectives and statement of data, confidentiality assurance and thanks in advance was attached with subjects of the study. Researcher too, used to explain her research theme and the reason for collecting their self-report data, especially, why for mathematics only. Last but not the least, it was highly cautioned by the researcher not to impart any personal thinking through any comment to subjects. Further, researcher personally moved school to school to collect the data in order to maintain research and ethical standards and to avoid the violation of invasion of privacy.

In the next section, the first two steps of the research design, that is, items generations and the procedure of instrument development are presented.

SECTION FOUR: SCALE DEVELOPMENT AND FACTOR ANALYSIS

Chapter.7 Scale Development Process

7.1 Introduction

Achievement in mathematics depends on students' competency and learning ability in mathematics. Research studies (Carroll et al., 2009; Geary, 1994; Iben, 1991; Ma, 2001; Ma & Kishor, 1997) showed that ability to learn and excel performance in mathematics is correlated with their positive attitude towards learning this discipline. Therefore, problems in learning and lower achievements of students in mathematics can be dealt by analysing and ameliorating their attitudes towards this discipline. Further, gender differences in mathematics achievements and issues of underrepresentation of women in mathematics related careers are also assuming to have relation with attitudes towards mathematics (Brown & Walters, 2005; Catsambis, 1994; Llyod, 2005; Post et al., 1991). Research showed that social factors and student's own perception have a vital role to play in creating such differences on the base of their attitudes towards learning and adopting mathematics. In addition, culture and social norms differ from society to society, thus, the influence of particular factors in one society may not be considered as significant in other society. Therefore, by keeping this fact in view, a research instrument to measure mathematics attitude is needed that may be applicable and compatible with the requirements and nature of the sample in Pakistani culture.

This section of the thesis is aimed at achieving the third main objective of the current research, that is, research instrument development. Current chapter, chapter seven, consists of two main parts; first part deals with literature available on the attitude measurement scales and necessary steps to develop a mathematics attitude measurement scale. In the second part, research process and results of preliminary survey are presented. In result, items banks are generated for developing the measurement scales of mathematics attitude and socio-psychological factors. While, the next chapter (chapter eight) of this section is based on refinement process of the measurement scales, and factors extraction through the pilot testing of the research instrument.

Before going towards the literature review of already existing attitude measurement scales in mathematics education research, below is presented briefly the concept of measurement of attitude.

7.2 Measurement of Mathematics Attitudes

Measurement is the assignment of the numbers to objects or events according to rules. The assignment of numbers must be orderly and must represent meaningful attributes and yield meaningful predictions (Dawes, 1985). Wright and Masters (1983) remarked that, measurement begins with the concept of continum on which people can be located with respect of some trait or construct (cited in Gable & Wolf, 1993; p.39).

In social sciences, this was quite challenging to present human charateristics or triats in a quantifiable manner in the form of index. In 1928, Lewis L. Thurstone wrote an article ‘Attitudes can be measured’ in which he defined the term ‘attitude’ systematically as feeling and verbal expression of the feeling. Whereas, opinion, as a verbal expression, is the indicator of attitude, that can be shown in the form of single index. It was believed earlier that attitude couldn’t be represented in a single index. He elaborated attitude’s measurement procedure by using the methods of *paired comparison* or *equal-interval* borrowed from psychophysics. Later, Fishbein & Ajzen (1975) also reported that attitude, measured as a single dimension, can be reported in a single score. They, further, emphasized that the most accurate measurement of attitude can be possible through affective domain of the attitude concept. They proposed the following formula to present attitude as a quantifiable index,

$$A_{O}= \sum_{i=0}^{n} b_i e_i$$

In this formula which represents Fishbien’s Expectency-value model, “A_0” is the overall attitude toward some object “O”, “b_i” is the belief about “O” and whereas “e_i” is the favourable evaluation of the attribute “i”.

Though, adoption of this formula to measure students’ attitude towards mathematics is not seen much. However, there are several other ways in mathematics education, which were elaborated to measure mathematics attitudes, like; Osgood semantic differential scale (Osgood, 1952), Ipsative measures (Cattell, 1944) etc. Following are presented some notable measurement scales for mathematics attitude, which covers a big portion of literature on research studies in this cadre.

7.3 Measurement Scales of Mathematics attitudes

Literature of already done studies, in the cadre of mathematics attitude measurtement, shows that there exist various measurement scales which are constructed to measure the students' attitude towards mathematics, sometimes by individual researchers and sometimes by organizations. Here, a brief literature review of few popular Mathematics attitude measurement scales is presented, which was consulted during the construction of scales for the present study.

Aiken, L.R

Aiken & Dreger in 1961 constructed a unidimensional measurement scale using Five points Likert scale format to measure the enjoyment and value of mathematics. Enjoyment of Mathematics (E-Scale) was consisted of 12 items and Value of mathematics (V-Scale) was comprised of 11 items. Later in 1974 & 1976, Aiken reconstructed and refined this mathematics attiude scale.

Dutton Scale

Dutton scale was developed in 1954 then revised in 1968 (Dutton & Blum). This scale was developed for measuring the "feelings" towards arithmetic.

Gladstone, R., Deal, R., & Drevdahl, J.E scale

Gladstone et al., in 1960 developed an unidimensional scale to measure the attitudes towards mathematics.

Frank C. Richardson & Richard M. Suinn

Richardson & Suinn developed a scale for measuring the anxiety in mathematics, which was called 'Mathematics Anxiety Rating Scale (MARS)' in 1976. This original MARS was 98 items scale test of daily situations to measure the level of test anxiety and mathematics anxiety in adults (Richardson & Suinn, 1972).

Later this test was replaced by MARS-30 Brief. Now they have developed four scales:

i. Mars 30 Brief; a brief version of original MARS 98-item sale.
ii. MARS-A; a 98-items scale for the students of 7^{th}–12^{th} grades (adolescent version).
iii. MARS-E: a 26-items scale for elementary school from 4^{th} to 6^{th} grades.
iv. STABS: the Suinn Test Anxiety Behavioral scale.

EDGE scales

Project EDGE was organized by Rochester Institute of Technology (since 1993 to date[67]). Under this project Mathematics and Science Attitude Inventory was developed to measure the attitudes of high school and college students. In this inventory, along with other scales measuring study habbits, academic preference, and self-assessment topics, a 64 items based questionnaire was included based on 4-points Likert scale.

Michaels and Forsyth

Michaels and Forsyth in 1977 developed *Multidimensional Attitude scales.* In their scale they measured enjoyment, appreciation of the utility of mathematics, and security with mathematics of sevnth grade students by using 4 and 5-point Likert's scales.

Fennema & Sherman

In 1976, Fennema & Sherman constructed an attitude measurement instrument named as, "Fennema-Sherman Mathematics Attitude Scale". This instrument was consisted of nine subscales:

i. Attitude towards success in Maths scale.
ii. Maths as Male domain scale.
iii. Mother scale.
iv. Father scale
v. Teacher scale.
vi. Confidence in learning mathematics scale.
vii. Mathematics Anxiety scale.
viii. Effectance Motivation scale in Mathematics.
ix. Mathematics usefulness sale.

7.4 Methods to measure attitudes towards mathematics

There is no fix or particular method available to gather data for measuring attitudes towards mathematics. Several methods have been used, like; interviewing, self-report, and observations by using the techniques such as; questionnaires, attitudes scales, projective, sentence completion, content analysis, etc., for the measurement of attitudes. Generally, there are two methods, which are most commonly used in a number of research studies to

[67] Source : http://www.nsf.gov/news/news_summ.jsp?cntn_id=109939

collect information about students' attitudes, these are, interviews and self-reporting. While, observational method was not found very often in research studies in mathematics education domain to observe the attitude of an individual in terms of his behavior. Here a brief discussion on these methods is presented.

Observational Method

Observation method is used to observe the individual's behavior towards certain object or stimuli. It is based on the assumption that attitudes can be inferred from overt behaviors or psychological reactions. In case of mathematics, certain intentions of students can be observed through the traits or actions of students in the class, but measuring their attitudes on the behalf of it, may contain inaccuracies in inferring their affective characteristics. Further, different situations, past behaviors, conditions may influence on the actions or behaviors during the observational period. It has other difficulties; that is, which behavior is to be observed and it represents which characteristic, moreover, what its implication regarding the measurement of the attitude towards mathematics has complications. Due to these complications, researchers sometimes avoid this methodology, especially, in the case of students' liking or disliking and perceptions, and attitudes towards mathematics. For example, a student may do mathematics in front of teacher or in exams due to the situation demand or pressure but might be in reality she or he doesn't like to do mathematics. To overcome these discrepancies, self-reporting method is used to assess the attitude.

Self-Report Method

Self-reporting method is mostly used method for the assessment of attitudes. In general, it includes the rating scales and psychological measures. Following is given the hierarchy of this technique:

1. Rating Scales
    a. Attitude scales
        i. The Thurstone (L.L.Thurstone, 1929)
        ii. The Guttman scale
        iii. The Likert scale
        iv. The semantic differential scale, etc.
    b. Inventories & checklists

c. Projective techniques
2. Physiological measures

To measure the attitudes towards learning mathematics, researchers used attitude scales for this purpose. In Thurstone scales, a questionnaire containing a series of questions or statements about the attitudinal object is given to the group of respondents to sort them into eleven piles. These piles represent an evenly graduated series of attitudes ranging from extremely negative to extremely positively. Dutton & Blum (1954, revised in 1968) used this scale to measure the 'feelings' of students towards arithmetic. While, Guttman scale comprised of set of statements about the same content, which are ordered along a continuum varying from least positive to most positive. Agreement with a statement means that respondent is agreed with all previous statements about the content. Score in this scale are "0" for "not agreed" and "1" for "agreed" with the statement. Whereas, in Semantic differential scale, the reaction against a given statement is measured through the set consisting of different pairs of opposite adjectives, for example; good-bad, happy-sad, beautiful-disgusting, fast-slow etc. Respondents are asked to check the mark either at any extreme end or in middle (which means neutral) of every pair of adjective. Or sometimes, respondants are given different levels of agreement to choose one among all.

However, the most commonly used rating scale for assessing the mathematics attitudes is Likert scale, which is chosen for the scales of current study (explained below). Whereas, other mentioned techniques were rarely used for measuring students'attitudes towards mathematics in the field of mathematics education.

Likert scale is the most commonly used and popular scale for measuring the mathematics attitudes because of its 'less laborious construction' and 'easy to use' characteristics. This scale was constructed by Rensis Likert in 1932 to measure the unidimensional construct, that is, all items measure the same attitude. For example; 'interest in mathematics' will be measured through different items based on the various aspects of the main entity. The feeling of the respondent is categorized from negative feelings to positive feelings divided into different steps or levels of agreement. Respondents are asked to select any one option of feelings against each item. These steps usually vary from 3 to 7. For example, three-steps score includes "agree", "undecided", and disagree". Whereas, the format following even steps like 4 and 6, undecided or neutral category is not introduced, however, agreement or disagreement categories are divided into two and three levels. Most appropriate and widely used levels in mathematics attitude scales are five and seven, example are given below in Figure 7.1.

Statement: ‘Mathematics problem is like a game to me in which I want to play and win’.

5- point Likert scale

Strongly disagreed,	disagreed,	Neutral,	Agreed,	Strongly Agreed
-2	-1	0	+1	+2

7- point Likert scale

Strongly disagreed,	moderately disagreed,	slightly disagreed,	Neutral,	slightly agreed,	moderately agreed,	Strongly agreed
-3	-2	-1	0	+1	+2	+3

Figure 7.1. Format of Five and Seven points Likert’s Scale

Afterwards, these levels, in terms of mentioned by the respondent against each item in the questionnaire, are converted into scores to sum up them in order to calculate the single value for the particular attitudinal object. The value thus obtained represents the degree of positive or negative attitude towards the mathematics. Because of this property, this scale is also called the summated rating scale.

Developing a scale requires certain obligatory considerations that are necessary to take into account. These consideratiuon that elaborate a comprehensive mechanism to get the pool of items is given below.

7.5 Considerations while developing a Scale

Scale development as a valid measure for certain characteristics is a complex and time taken process that follows some well-established procedural steps. Various psychologists, experts and authors proposed different entailed steps in the development of a valid and reliable scale. Literature contributed by various experts on the construction of a scale was reviewed but no single fixed procedure or rules are available. Insight of literature reveals that various experts differ in terms of internal infrastructure of each step. Though varied at minor levels, but all differences are prudent depending on the situation and form of the study and sample. The more noteably work of William Foddy, De Vellis, Gable & Wolf, Netemeyer et al., Pourtois & Desmet etc, were cited in order to develop the measurement scales for present study. Here, the procedure that is adopted to develop the mathematics attitude measurement scale, and influence of social factors measurement scales is discussed briefly and concisely.

Constructs Definitions

The most important and first step in the development of the scale is to define the constructs and factors that are focused to explore in the study in the light of set research objectives. Operational definitions of the main key terms help one to distinguish the limits and dimensions of the factors, and thus, precise the subject and content of the items. In the present research project, the main latent variable, that is to be judged with the help of other related influencing factors, is mathematics attitude. Mathematics attitude includes two constructs, that is, mathematics belief and mathematics interest, whose dimensions are already defined in the first chapter. In addition, the clear and concised definitions of these constructs are also proposed. The other dominant factors of our study are parents' effect, teacher's influence, self-beliefs, and stereotypic beliefs, are discussed in detail along with their dimensions of measurement in the second chapter. For example, proposed dimensions of parents' effect are their socio-economic status & help, their expectation and motivation. This study is intended to measure teacher's influence by studying the students' perception of their teacher's behavior, her or his pedagogical skills & content mastery, and encouragement. Moreover, for self-perception beliefs, it is assumed to study mathematics self-concept and mathematics self-efficacy. Therefore, for the sake of specifying the content areas of all variables that are intended to measure in this project, operational definitions of these main key terms were presented in Appendix 1

Item Sources

The next step, after precising the operational definitions of the research variables, and literature review for the factors, and constructs of the study, is to specify the sources for generating the items for the scale. In this study, we are intended to develop various scales, these are; perception of parents' influence scale, perception of teacher's effect scale, self-perception beliefs measurement scale, and stereotypic beliefs measurement scale, along with the mathematics attitude measurement scale. Therefore, in-depth knowledge of each of these mentioned factors were required to study. Thus, three major sources were specified in order to develop the items bank for the variables of concerning factors, these are; literature review of studies already done in this cadre, Attitude measurement scales (as are mentioned above) and the preliminary survey. Literature review and mathematics attitude scales helped us to understand the content premises and language of attitude statements. Further, to develop the mathematics attitude measurement scale and other mentioned scales in the context of

Pakistan. A better understanding of the students' feelings and their perceptions regarding these particular factors is needed under the prevailing conditions of the Pakistani society. Therfore, to achieve this goal, a small-scale survey study was conducted in the universities of Pakistan. In the light of the results of this preliminary survey and literature review of already done studies, attitude statements were constructed for the items bank for each scale. Detailed procedure of this preliminary survey and results & discussions are presented in the next chapter.

Statements Writing

Statements writing step in the development of the measurement scale is very delicate process. A little change in the combination of words can alter the meaning of the statement thus needs to be taken with care. It includes several standards that have to be met to develop such statements, which can serve as potential and determining items. The foremost standard is 'wording' and 'clarity' of the idea presented in the item. The wording and clarity of the sentence ensure the level of validity of any statement.

In addition, the next important standard while generating items for the scale, is to avoid ambigious idea in an item and *double-barrel statements*. Therefore, it was taken great care in the construction of items for the scales for current research, that a statement having more than one idea or addressing two issues must be avoided.

In the present study, our final sample subjects of the study are school students aged between 10 and 15 years, therefore, the selection of the words and clairity of the statment were made according the comprehension level of students. Further, as present study is designed to conduct in Pakistani schools where Urdu is used as a language of communication and medium of instruction in government public schools, therefore, an instrument in Urdu language would more efficace than in English language. To realize this, at first stage, items were generated in English language because it was the requirement of the thesis and then passed through the process of face and content validity process to have the measurement scales. At next stage, these valid statements were translated into Urdu language; in this process due to the constraints of language differences exact translation of items sometimes was not possible. Therefore, extra effort was paid with the help of English language teacher whose native language was Urdu to realize this procedure in order to maintain the same theoretical idea of the statements. After gone through this process of translation, initial face vailidity and content validity was ensured of these statements through the experts in this field and Urdu language school teachers keeping the linguistic comprehension level of students in mind.

The other pertinent issue that was considered while writing the statements is negative and positive worded format. Negative and positive items are those items, which represent the absence and presence of a particular characteristic or construct of interest respectively (De Vellis, 2003; Netemeyer et al., 2003). De Vellis explained the reason of why both types of items (positively & negatively worded) are pertinent to present in a scale, is usually to avoid *an acquiescence, affirmation, or agreement bias* (p.69) and *keep the respondent honest* (Netemeyer et al., p.99). Many researchers and experts argued that if a scale consists of only positively worded items or only negatively worded items then there is much more chance of acquiescence biasedness in the responses, which means, respondents would show a very high level of agreement or particular construct or in other case, they would exhibit intentionally a highest level of disagreement (Cacioppo & Petty, 1982; De Vellis & Callahan, 1993; De Vellis, 2003; Netemeyer et al., 2003; Nunnally, 1978). Therefore, a scale having both types of items and in balanced quantity would result in overall balanced level of agreement for a construct. In this study, both positive and negative worded items were generated to avoid the biasedness in responses and thus the degree of honesty of respondents was tried to ensure. For this, sometimes, the rule of "wording redundancy" was followed to ask same idea in two items; one with positve format and other in negatively worded form. For example, *I feel hesitation to ask questions to my mathematics teacher during period* and the other is; *I ask my teacher during lecture if I don't understand the topic*.

There are also disadvantages for this combination that correlation between the negative and positive items often observed low. In addition, this may evident in factor analysis pocedure too that, positve items tend to load on one factor while negative worded item load highly on other factor (De Vellis et al., 2002; Gable & Wolf, 1994; Herche & Engellend, 1996). Apart of these advantages and disadvantages, researchers should take decision on the base of the nature of the study and subject of the items.

Response Format for Scale

There are various formats for responses, which are used according to the nature of the scale as explained before. The selection of response format is done at two stages. First, it is decided what format is going to be adopted in the scale before generating the items because format of the item and their wordings depend on this decision. Later comes the step of analyzing the responses, on the base of which, these generated decelarative statements are to be judged in respect of degrees of the agreement. The basic aim, to offer multiple levels of agreement, is to elicit the fine discrimination among the different levels or degrees of responses. For this study, five-points Likert Scale is chosen as response format and thus generated declerative statements, by keeping wording and idea according to the demands of Likert scale.

The other major steps in the construction of the scale are the validity of generated items, and then to reduce the large pool of items into most correlated and reliable ones with the help of suitable reliability measure technique and Factor analysis method.

7.6 Development of Mathematics Attitude Measurement Scale

Development of a measurement scale for mathematics attitudes is gone through different steps and procedures. These procedures can be broadly divided into two main sections; in first part, items bank is constructed which is in itself a research procedure and therefore, needs a well-designed methodology. Afterwards in second section, these items in the form of a scale are scrutinised through reliability and validity processes. In the end, this scale was passed through the factor analysis procedure in order to determine the factors measuring some particular characteristics.

As the current study is dealing with the sample of students of class 6 (11years old) and class 9 (13-14 years old), therefore, two measurement scales of attitude towards mathematics will be developed. As mentioned above that we need to specify those variables, which affect attitudes of the students towards mathematics. Thus, to achieve this goal, we conducted a preliminary pilot survey and informal interviews with the university students of Pakistan. This chapter deals with the first part of the scale development, that is, construction of items bank for the mathematics attitude scale, through the results and discussions on the preliminary survey data.

Why A New Scale?

Attitudes are related to some definite stimuli or stimulus situation. These may include objects like, parents, teachers, classroom environment, motivation, and social setup etc. Further, attitude towards some particular object of an individual depends upon the intensity and degree of relationship of the individual with that particular object under the influence created by personal and social factors, which also help on in deciding the preferences. Due to this established fact of differences in preferences, an attitude scale, developed for the students belonging to one society may not be applicable effectively to the students of some other society, which do not share same societal norms, cultural values or economy. Literature review reveals us that mostly mathematics attitude measurement scales are developed by western world for their students who are studying in a very different education system. Moreover, living in a very different society whose societal and cultural infrastructures and values are quite different from Pakistan’s. Therefore, modifications in already developed scales or the construction of new attitude scale for mathematics was required according to the stimuli and situation. So, in case of modifications or if new scale is needed then it is obligatory for the construction of instrument that we should have the knowledge about the effecting factors, their dimensions, and degree or intensity of effect as the variables in the formation of attitudes. Therefore, the first restriction for developing an attitude measurement instrument is to specify an attitude variable and limit the measurement to that (Thurstone, 1928) which is already defined in the first section for mathematics attitude and influencing factors.

7.7 Research and Methodology of Pre-Pilot survey

Pre-pilot survey in itself is a complete research, therefore, a well defined and well-designed research methodology is required like in any other research study. The main objective of this pre-pilot or preliminary survey was to gather the data on the viewpoints of students about adopting or avoiding mathematics. Thus, for this purpose, a semi qualtitative survey research method was used to conduct this study. Therefore, those students who were studying mathematics as major in graduate and postgraduate programs were decided to be the sample for this preliminary survey. The target population for this survey was all students from Bachelor (Mathematics) and Master (Mathematics) programs from the universities and postgraduate colleges in Punjab. For this purpose, Lahore was selected as a sample city through convenience sampling and a sample of institutes and students was selected from this city. Detailed procedure of sampling and data collection is given below.

7.7.1 Sample

A purposive sampling technique was used for this survey and the 94 students (65 women and 29 men) from three institutions (Lahore College for Women University, Govt. College University and Govt. Science College) of Lahore were selected. These students were studying Mathematics as major at graduation level or doing masters in Mathematics. Distribution of sample from each institute is given below:

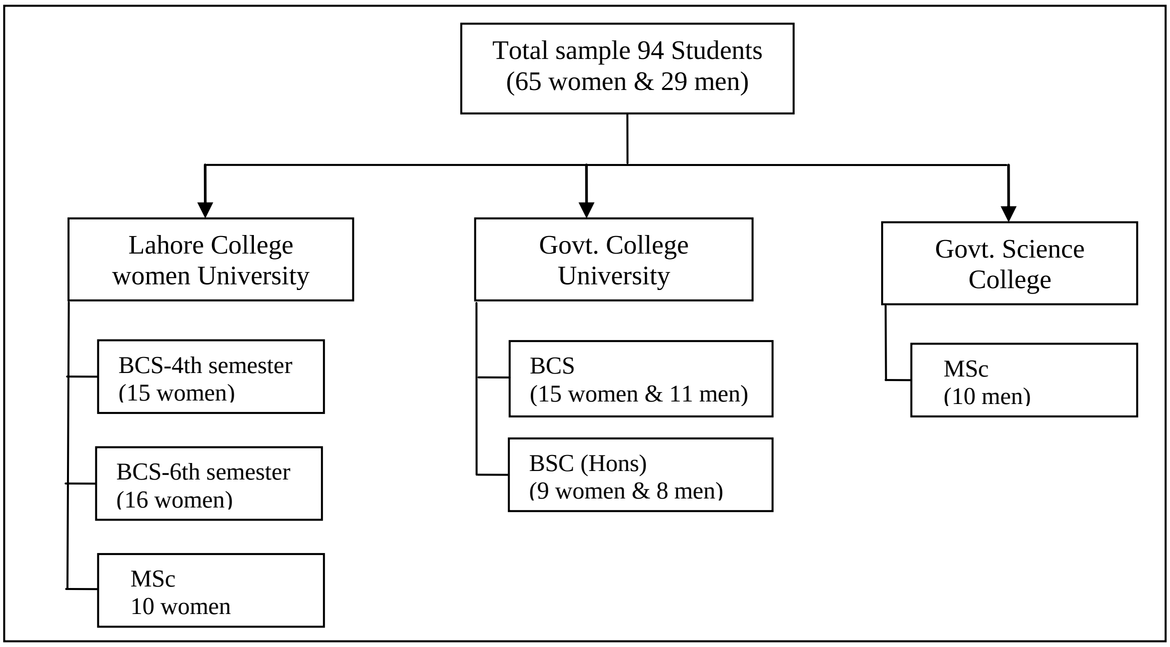

Figure 7.2. Sampling distribution of three institutes

7.7.2 Instrument Development

An instrument was developed for this preliminary survey, which was consisted of three major sections. In first section, a cover letter was established for the respondents in which they were introduced clear & concise objective of the survey, problem statement and significance of this study. To motivate the respondents to participate in this survey, importance of their responses in order to explore the research problem and confidentiality of provided data was assured in the cover letter. In the last, a request of their cooperation with thanks was mentioned (Instrument is given in Appendix 2).

For next section, a questionnaire was developed consisted of portion of basic information about gender of the student and year of study, and two open questions. In this part of questionnaire, respondents were asked to describe at least five reasons, in the first question, for opting mathematics at advance level and the contributing factors in this decision. In the next question, students were asked to write the possible reasons behind the avoidance of this subject or not choosing it as a major. They expressed their view points in the light of their past experiences and observations about the teachers, contribution of parents, stereotypes, and importance of mathematics, etc. For later section, a checklist was constructed in the light of literature review and attitude scales for mathematics. Respondents were asked to select at least five most effecting factors from the checklist along with the ranks starting from 1 'most important' to 5 the 'least important' in developing the attitude (positive or negative) of the students towards mathematics.

7.7.3 Administration of pre-pilot survey questionnaire

In this survey, 98 students from total six programs of three institutes were participated, therefore, researcher made multiple visits in each institute. As it is shown in design too, stage prior to data collection process was to contact heads of the departments of mathematics in order to obtain approval for conducting survey to their students from different programs. Therefore, meetings with heads were fixed on telephone, E-mails and sometimes, in-person visiting them. After having approval confirmation of dates, times and programs, next stage was to conduct the survey in these departments. In every session of survey administration, an informal discussion with students was done in which brief introduction of researcher, brief introduction of research and objectives of the survey were conveyed so that they may get mentally agreed to participate in the survey.

All institutes allowed approximately 45 to 60 minutes time for each session with respondents. As mentioned earlier, that questionnaire was consisted on two parts to attempt therefore, researcher first delivered first part of questionnaire consisted of open questions and after 20 to 25 minutes, next part was provided. This whole procedure was easily managed within time limit.

7.7.4 Data Collection and Analysis

Data collected in preliminary survey were rearranged by reading critically each reply from students for both questions. These reasons were then distributed into categories that were revealed in the responces. By using tallies and grouping method, these reasons and causes given by students then recoded again into major categories and under each category related sub categories were transformed in to frequency distribution. The data coding procedure is illustrated is below.

Data Coding

After analyzing the text related to first question, total 34 reasons were found from the data with different frequencies in the favour of adopting mathematics at advance levels. These reasons were then regrouped according to their similar premises. In the second question, total 33 reasons were coded against the question demanding the reasons of avoidance of mathematics at advance level or of negative attitudes towards mathematics. These reasons were further distributed into six categories in favour and in against. Table 7.1 presents these factors with their codes.

Variables	Codes	Variables	Codes
Liking or enjoying mathematics under Interest.	I	Image or perception about mathematics	NI
Importance beliefs of mathematics	B	Less scope	NB
Teacher Influence	T	Teacher negative influence	NT
Parents or family influence	P	Parents' influence	NP
Individual's personal feelings or experiences	S	Individual's personal traits	NS
Other social stereotypes or reasons	ST	Other reasons	

Table 7.1: Coded Categories of factors found in preliminary survey

Following is presented the analysis of each variable category in order to generate possible statements for items bank of the research instrument of present study.

7.8 Items generation for Mathematics Belief

Belief as the construct of mathematics attitude is the core factor of our study. As mentioned earlier in first chapter, that mathematics belief is the student's evaluative association that she or he establishes between mathematics and its various attributes particularly concerned with utility and value of this discipline for her or him, or for society.

Data collected from this survey also provided the traces of mathematics global beliefs that students possess in order to adopt this discipline. Results of the data and its content analysis discussion are given below.

Results and Coding process

Data provided by the repondents is a rich pool of variables, which play very vital role in developing attitudes towards learning mathematics, and thus help in increasing the proportion of youth pool in engineering and technology fields. Regarding mathematics belief, students mentioned different prospects that would be pertinent to study the problems and issues in students' attitudes towards mathematics. Total nine reasons are derived in the favour and five causes of not adopting mathematics, under the category, mostly indentified usefulness and value belief of mathematics. A major proportion of respondents, approximately 34%, argued that mathematics is unique in a sense that it is conceptual and therefore, cramming in it cannot work. According to them, this characteristic brought them to adopt this discipline. Thus, we can define it as variable "conceptual, no need of cramming: B_cncp".

Further concerning its importance in science and technology, 30% respondents mentioned that mathematics is the discipline, which is used in every science without which related scientific advancements may not be imagined. Therfore, B_imp is proposed as coded variable to mention the mathematics belief of importance. In addition, in daily life use, its importance was also reported by 27% of the students, conciouseness of this belief was the reason to contunue this discipline in advance studies. This is coded as variable "imortance in daily life: B_lfe". However, 16% of the students also had perception that students who fail to realise this fact, they lose interest in mathematics and thence don't continue it at advance levels.

Moreover, respondents also mentioned belief in financial perspective as the motive of their higher studies in mathematics. 29% of the respondents mentioned that they believe that mathematics provides "better financial benefits" or by adopting mathematics related career, one can have economically secured future. Therefore, variable of 'better financial & secured future: B_fin' can be derived. On the other hand, 30% of the respondents opined that those students who possess little knowledge of the scope of mathematics usually don't take interest in this subject. For example, one wrote, "in schools, teachers do not give knowledge about its scope" which also indicates lack of teacher-student interaction regarding preparation of students for future career. However, those students, who have some perception about the scope of this discipline, embraced it in any form for future careers. Thus, here this variable is coded as B_scp.

Furthermore, concerning self-satisfaction, intellectual development belief is also mentioned. Data of this survey depict that respondent also appreciated such beliefs for having positive attitude towards mathematics. It was reported that mathematics enhances analytical thought. Variable B_anl represents students' such belief, i.e., they think that mathematics makes one to think analytically due to the complex problems and enables them to resolve logically. Similarly, in the same premises of thinking, 22% of the students affirmed that through mathematics, one becomes able to approach the solution of any problem through different ways. Such attribute prepares oneself for practical life to look beyond the things. Thus, variable B_tnk represents belief in developing mathematical thinking skills.

Another reason that respondents appreciated for mathematics is its clear and concise nature of content material, coded under B_clr variable. 22% of the responces presented the idea that the beauty of mathematics, which makes it different from other school subjects, is its language and concepts. One doesn't need to explain what she or he wants to says, she or he says what solution wants her or him to be said. Following table 7.2 presents all derived variables under this category along with their codes.

	Mathematics Belief Coded Reasons	
Total	**In Favour**	**B**
1.	Importance in science & Technology	B_imp
2.	Better financial & sound future	B_fin
3.	Better scope	B_scp
4.	Importance in daily life	B_lfe
5.	Enhance Analytical thought	B_anl
6.	Develop Thinking skills	B_tnk
7.	Clear & precised	B_clr
8.	Comprehensive & directly applicable	B_appl
9.	Conceptual, no need to rote	B_cncp
	Against	NB
1.	Not practical or applicable directly	NB_appl
2.	Continuing Maths at adv level has less financial benefits.	NB_fin
3.	No scope other than teaching OR less knowledge is given at school.	NB_ scp
4.	Less relevance with real life.	NB_lfe
5.	Low marks giving subject/risk to lose.	NB_mrk

Table 7.2. Variables Codes of mathematics Belief

Lastly, the variable that was found from the data representing mathematics beliefs is about the practical application of mathematics. 24% of the students indicated that they chose this discipline because of the comprehnesive and direct application of mathematical concepts. On the other hand, 14% respondents believed that those students avoid mathematics, who are unable to understand the application of its concepts. Few students reffered this cause due to mathematics teachers, which is discussed later in this chapter under the factor of teacher’s influence. Another cause NB_mrk, though mentioned by few respondents but it seems pertinant to discuss, that students also avoid this discipline due to the fear of losing marks in exams. As variable B_clr depicts that competency to solve of mathematical problems is the only way to qualify the mathematics exam, therefore, personal viewpoints or detailed explanation that may work in other school subject have no place in this discipline.

Following graphical representation presents the reoccurrence ratio of above discussed variables for mathematics belief (cross-lined bar is mentioning favourable cause and slope-lined bar is representing in against reason).

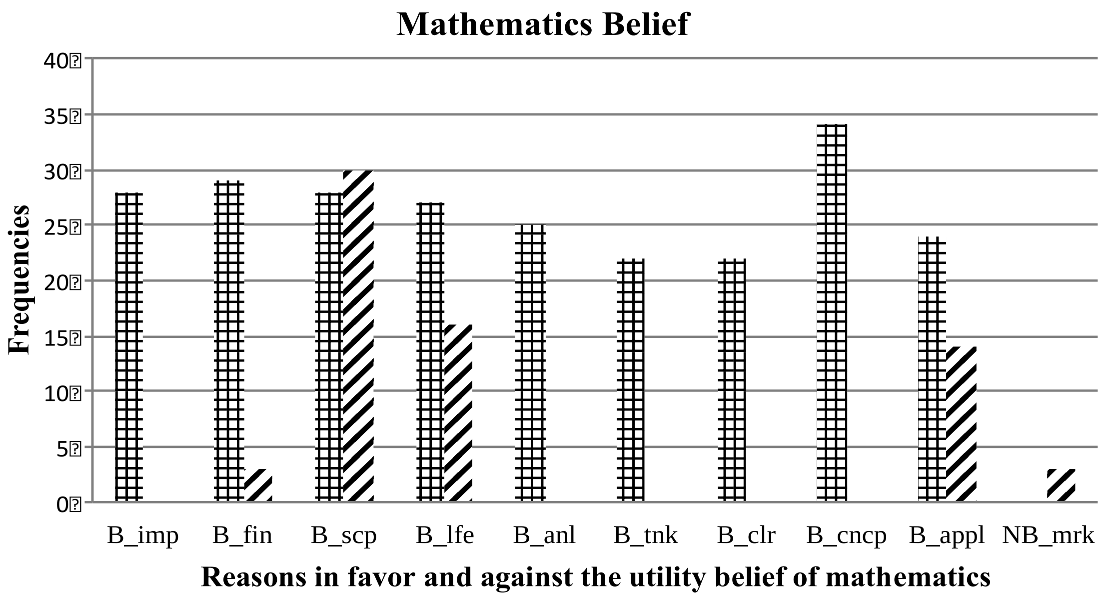

Figure 7.3. Frequency graph of variables for Mathematics Belief

Discussion

Here, the results are discussed in order to generate items for the scale to measure the level of belief of students in utility and value of mathematics. In the following table 7.3, reasons in the favour and against of mathematics belief, reported by the respondents, are compared in order to make possible combinations of ideas to construct statements.

In Favour (positive points)	Against (negative points)	Relevance
B_imp. B_fin. B_scp. B_lfe. B_anl. B_tnk. B_clr. B_appl. B_cncp.	NB_appl. NB_fin. NB_scp. NB_lfe. NB_mrk.	Variable B_imp with NB_appl. B_fin & B_scp with NB_fin, NB_scp. B_lfe with NB_lfe. B_cncp with NB_mrk

Table 7.3. Comparison of variables in favour and against mathematics belief

As it can be seen that the variables B_appl and NB_appl, both are mentioning the "application" characteristic (direct or indirect) of Mathematics in other domains of sciences, therefore, these variables can be coordinated with the importance of mathematics in technological advances evident from literature review. Further, these days, technological advancements in any country are the assurance of better economy, and thus, development of country highly depends on it. Therefore, keeping this connection of mathematics with the development, following possible statements can be formed:

- We find the utility of mathematics everywhere in the world. Or, There is no technology without mathematics.
- Mathematics is important for the development of the country.

In addition, if same characteristic of B_appl is combined with the variable B_imp, then at school level, appreciation importance of this disciplines can be judged through this item,

- Mathematics is most important subject among all subjects in school curriculum.

Next comes the “scope and financial benefits” of the mathematics, in this cadre, belief variables ‘B_fin’ & ‘B_scp’ can be correlated with the negative beliefs ‘NB_fin’ & ‘NB_scp’. This means that the students who think that studying mathematics at advance level has wider scope and one can have better financial opportunities, shall continue with this discipline. Whereas, the students who have perception that mathematics has very narrow scope for future profession or less financial benefits, they will not choose this discipline for their higher studies. Keeping this fact in view, following attitude statements can be developed:

- Mathematics is necessary to get a good job.
- With mathematics we can get scholarships or part-time job easily to cover our educational expenses.

The other idea mentioned by the respondents is about the “relevance and importance” of mathematics in the daily life matters. Both poles (positive & negative) of an attitude about the necessity of mathematics can be observed in statements ‘B_lfe’ & ‘NB_lfe’. The following phrases may measure the same idea:

- We can spend a good life without mathematics.
- We don’t need mathematics in daily life. Or, Mathematics has no relevance with real life.
- I don’t know how to use school mathematics in my life. Or, I don’t see the use of mathematics concepts around me that I study in mathematics book.

The next idea about the nature of the content-material can be explored by combining variables B_clr & B_cncp to judge the students’ feelings of interestingness based on this belief. And can rephrase it in the following statement;

- Mathematics is not creative; it’s just about memorizing formulas and steps.

Another reason that was mentioned in the variable B_tnk and B_anl depicts the belief of students in mathematics being a source of developing thinking skills and analytical reasoning may be measured as mathematics attitude of students. Therefore, following statement can be proposed to develop an item in this cadre;

- Mathematics helps in developing a person's mind and teaches him how to think.

Items bank for Scale Development (Mathematics Belief)

Possible attitude statements regarding utility of mathematics:

1-	Mathematics is the most important subject among all subjects in schools.
2-	Mathematics is important for the development of the country.
3-	We find the utility of mathematics everywhere in the world. Or, There is no technology without mathematics.
4-	With mathematics we can get scholarships or part-time job easily to cover our educational expenses.
5-	Mathematics is necessary to get a good job.
6-	We can spend a good life without mathematics (without using mathematics) in our daily life.
7-	We don't need mathematics in daily life. Or, Mathematics has no relevance with real life.
8-	I don't know how to use school mathematics in my life. Or, I don't see the use of mathematics concepts around me which I study in mathematics book.
9-	Mathematics helps in developing a person's mind and teaches him how to think.
10-	Mathematics is not creative; it's just memorizing formulas and steps.
11-	We need to do better in mathematics if we want to become famous.

Table 7.4. Items bank for the scale of utility and value belief of mathematics

7.9 Generation of Items for Mathematics Interest

Mathematics interest is the second construct, which shares the foundations of the concept of mathematics attitude. Interest in mathematics, which is taken as the final outcome of one's feelings and sentiments towards mathematics, sometimes, alone considered as the mathematics attitude in studies (cf. Aiken, 1970). In current research, mathematics interest is assumed as the feelings of enjoyment, liking mathematics and interest triggered psychological state while doing mathematics. Major portion of the responses in this survey indicates enjoyment and interest in mathematics as a major reason to adopt mathematics in higher studies. Detailed results and determined variables and their codings are given below.

Coding and Results

As compare to mathematics belief scale, under mathematics interest variable the opinions given by respondents depict very clear and distinct sentiments. Almost all students gave their views about interest in mathematics, mostly utilised words of interesting, liking, and enjoyment to mention their interest in mathematics. These responses were categorized in eight variables while five variables were found in the reply of second question that were simply the negations of reasons mentioned in the first question. Following table shows these variables along with their codes that were explored in the responses of students in the favour and against mathematics.

No.	**Responses**	**Codes**
In Favor	**Interest**	**I**
1.	Had interest in school mathematics.	I_int sch
2.	Enjoy doing mathematics	I_enj
3.	Like mathematics.	I_lke
4.	Sums are challenging like games/puzzles.	I_gms
5.	Can get good marks.	I_mrk
6.	Evergreen subject/queen of all sciences.	I_sci
7.	Less time is required to do mathematics.	I_tme
8.	To be different	I_dfr
Against	**Don’t Interest**	**NI**
9.	Dry& boring subject	NI_bor
10.	Difficult subject.	NI_dif
11.	Poor exam system/boring syllabus.	NI_sylb
12.	Time consuming discipline & needs full attention.	NI_tme
13.	Tiresome and make tense	NI_tens

Table 7.5. Table of variable codes of mathematics Interest

The most reported reason in the data was ‘enjoyment in doing mathematics’. Total 53% of the students replied that they adopted mathematics as major because in schools they enjoyed doing mathematics problems. Therefore, according to them, those students who lack in such enjoyment usually do not pursue mathematics after their high school. The next major reason that was mentioned by 42% of the students is that they had interest in school mathematics, though they didn't specify the dimension of this interest, this reason is considered as a variable to develop related attitude statement for the scale. In the same cadre, 17% used the word "like mathematics" to show it as a reason to continue mathematics.

On the other hand, rather compounded cause, which was mentioned by 40% of the students to avoid mathematics is, its difficult content-material or "mathematics is difficult". Respondents were of the view that those students, who face anxiety and tension in mathematics, as mentioned by 18% of the respondents, find this discipline difficult and thus experience negative attitudes towards this discipline. The other cause to avoid mathematics, which was mentioned by 30% of the students, is amount of time and attention, which is required in this subject more than any other school subject.

Above mentioned categories of responses are given in frequency graph in figure 7.4, to get further idea of the intensity of different reasons in favour and in against. In this graph, cross-lined bars represent the reasons of adopting mathematics while slope-lined bars represent the variables cause mathematics avoidance.

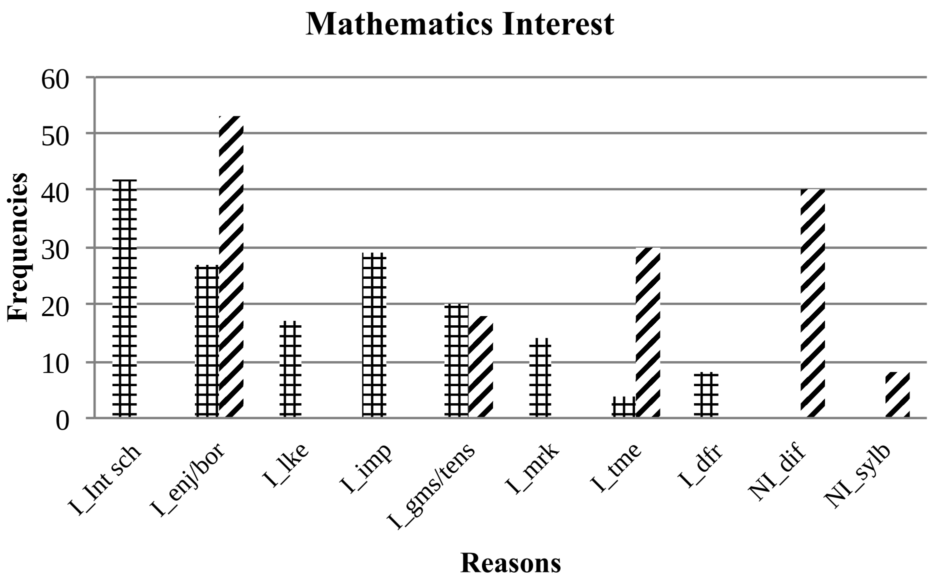

Figure 7.4. Frequency graph of reasons for Mathematics Interest

Another notable reason as shown in frequency graph, coded as "I_imp", which is mentioned by 29% of the respondents. This feeling of interest in mathematics that develops on the basis of belief, in fact, shares the common boundries of value as mentioned in first chapter under the mathematics interest dimension ‘individual interest as disposition’. The other example of such value component is I_mrk variable. 14% of the students reported interest in mathematics on the base of benefit belief of getting good marks. Therefore, those students who get good marks in this discipline, they get attracted towards this discipline.

Other interesting fact was revealed that about 8% of the respondents quoted that they adopted mathematics just to be different from others. This can depict the sense of be different from others or satisfy ego. As one wrote “*all people think mathematics is very difficult so I chose this subject just to show that I do difficult things*”. Another interesting comment, “*whenever I tell anyone that I’m studying mathematics major, she or he gets impressed from me*”. Therefore, we coded this variable I_dfr to examine this characteristic of students.

Now on the base of these explored variables, following is presented the result discussion in the light of literature review to construct items under this category for mathematics attitude scale.

Discussion

As we mentioned above and from graph it is even more clear that statements under mathematics interest are clear and distinct.

Mathematics Interest.	**Mathematics disinterest**
i I_int: Had interest in school mathematics.	**a.** NI_int: Dry & boring subject.
ii I_enj: Enjoy doing school mathematics.	**b.** NI_tens: Tiresome subject, make tense.
iii I_lke: Liked it (some stated “don’t know why?”	**c.** NI_diff: Difficult subject.
iv I_tme: Easy to do & less time is required.	**d.** NI_tme: Time consuming and time is required to understand.
v I_mrk: Can get good marks.	**e.** NI_sylb: Poor marking system & bore maths syllabus
vi I_sci: Evergreen subject/Important among all subjects.	
vii I_gms: Sums are challenging like games	

Table 7.6. Comparison of variables in favour and against mathematics Interest

Here in above table, the reason, which most of the respondents mentioned to continue advance mathematics, is that they had interest in school mathematics without specifying the cause of the interest. But if we look in other responses like “I_enj” mentioning enjoy to do maths and “I_mrk” one can get very good marks, then it can be assumed that sense of enjoyment or having good marks may raise interest in this discipline. Further, “I_lke” reason mentioning “liking” instinct, quoted by few students, that they don’t know why they do so, may also have the same cause of enjoying or good marks. Therefore, we propose two statements on the base of this assumption;

- I enjoy studying or doing mathematics
- I like mathematics because we can get good marks in it.

On the other hand, the reason that they don’t know why they like mathematics may be dealt in the negative form for those students who don’t like it, even having good marks in it. Research indicates that this is the case especially for girls who, despite of their better achievements and securing good marks in mathematics, do not continue this subject (cf. Fourth chapter, the case of Pakistan in Fig: 4.1 & 4.2). Therefore, the following attitudinal statement can be formed:

- I dislike mathematics even if I get good marks in mathematics.

In the same cadre of interest in doing mathematics, the variable “I_gms: sums like games” offered by the respondents indicates the enthusiasm of a student that she or he feels while having some challenging mathematical problem. Therefore, this feeling or sentiment can be transformed into the following attitudinal statement;

- Mathematics problem or sum is like a game to me, which I want to play and win.

Further, the variable “I_sci” indicates students’ appreciation for mathematics over other disciplines in school curriculum, therefore, serves as interest enhancer to continue it at advance levels too. In addition, mathematics is a compulsory subject in school curriculum till secondary level in Pakistan, therefore, to measure the level of appreciation of students for this discipline we state this sentiment in negative from.

- Mathematics should not be the compulsory subject in school curriculum.

On the other hand, among the reasons for not opting mathematics after high school or disliking this discipline, a great number of students mentioned (which is evident in research too) that mathematics is believed as dry & boring subject. Similarly, other mentioned cause is "NI_diff: mathematics as difficult subject". Here, it will be pertinent to mention that such feelings in mathematics interest share the boundary of value and belief as mentioned in first chapter. These reasons are significant for those students who perhaps haven't developed their competencies in abstract concepts because other sciences like physics, chemistry etc., may fascinate students by their practical implications directly in school laboratories. But as far mathematics is concerned, one needs to develop her or his intellectual skills or must arrived at formal operational stage to understand reasoning in order to appreciate the practicality of the abstract concepts of mathematics. The variable "NI_tme: need time to understand" also support this explanation, therefore, a possible statement can be;

- Mathematics is difficult to understand.

Mathematics follows well-defined pattern of concepts to reach at the solution of the problem, in which, very precised and comprehensive logical work is required. These characteristics of mathematics make this discipline unique from other sciences where words can play a role and student may be liberal to some extent in her or his explanations of phenomenon in discipline like, biology, physics or language and social sciences etc. Further, in prevailed mathematics syllabus in Pakistan, less intention has paid towards introduction of different methods to approach solution. Further, in mathematics examination, analytical reasoning is paid less attention while judging students' mathematical competencies rather lengthy solution of problems are focused more, which may foster the need of roting or memorizing the formulae for students to qualify the exam. Moreover, the threat of losing marks is much higher in this discipline than any other science subjects. These may be the significant reasons for students to get annoyed or irritate from this discipline and thus, suffer from mathematics anxiety. Here, statement may be proposed of negative feelings, the effect of both statements may explore the reason of such attitude of students, that is;

- Mathematics is dull & boring because we can't explain the things in our own words.
- Mathematics is just to get the correct answer.

Moreover, to explore the effect of anxiety in developing negative attitude of student, this statement will be pertinent to ask,

- Mathematics makes me tense and uncomfortable.

The perception of mathematics in general is very tough and very dry subject and only intelligent or God-gifted students can do it. Due to this, a perception may develop that, if "I'll do better in this subject then people will definitely get inspired of me or they will show some sentiments of surprise or appreciation". Therefore, in the cadre of variable code "I_dfr", i.e., "makes one different", following attitudes statement may measure this kind of feeling of the students;

- We need to do better in mathematics if we want to become famous.

Scale development

To measure the interest of students in mathematics as a construct of the mathematics attitude, the following scale is derived from the above analysis and discussion:

1. I enjoy studying or doing mathematics
2. I like mathematics because we can get good marks in it.
3. Mathematics problem or sum is like a game to me which I want to play and win.
4. Mathematics is difficult to understand.
5. Mathematics is dull & boring because we can't explain the things in our own words.
6. Mathematics makes me tense and uncomfortable.
7. Mathematics should not be the compulsory subject in school curriculum
8. Mathematics is just to get the correct answer.
9. I dislike mathematics even if I get good marks in mathematics.
10. We need to do better in mathematics if we want to become famous.

Table 7.7. Item bank for Mathematics Interest scale

7.10 Scale Development to measure Teacher's Influence

Research indicates, and in our hypothesis too, that teacher is the important social factor that influences mostly student's attitudes towards learning mathematics. In this study, teacher's influence is considered as student's perception of mathematics teacher behaviour with her or him, perception of his pedagogical skills & content knowledge, and his encouragement to student in learning mathematics. Thus, keeping this concept in view, data collected from university's students were analysed in this frame and found that students themselves put a great emphasis on this factor. Students mostly mentioned dissatisfaction, up to a great level, in different aspects of this factor. However, inspiration from mathematics teacher was mentioned as a major reason to continue this discipline in advance level. These reasons in coded forms are given below.

Coding and Results

Under this category, total five main variables regarding favourable influence and seven mentioning negative effect of mathematics teacher were coded, which are given in the table 7.7:

No.	**Teacher factor** (T)	Codes
1.	Inspired from Mathematics teacher behavior.	T_bhv
2.	Inspired from teacher's methodology.	T_mtd
3.	Teacher had in depth content knowledge	T_knw
4.	Motivation & encouragement from teacher.	T_crg
5.	Wants to be good teacher of Maths.	T_tch
	Negative points:	NT
1.	Unfavorable behavior of teacher.	NT_bhv
2.	Poor or uninteresting teaching methodology	NT_mtd
3.	Teacher has not enough content knowledge	NT_knw
4.	Discouragement from teacher.	NT_crg
5.	Didn't find good teacher of Maths.	NT_tch
6.	Lack of communication with teacher.	NT_com
7.	Lack of Maths teachers in schools.	NT_notch

Table 7.8. Coding for mathematics teacher's influence variables

The data provided by respondents show that, inspiration from teacher and her or his motivation or encouraging behaviour were two main variables mentioned by a great number of students as the favourable reasons for adopting mathematics in advance levels. Respondents expressed different reasons for the inspirations, which are coded into three categories; teacher's behaviour, teacher's pedagogical skills, and lastly, perception of mastery over content knowledge. Further, motivating & helping attitude of teacher and her or his encourage towards learning mathematics what students had experienced from their teachers mentioned under code “T_mtd”. In addition, few respondents indicated their desire to be mathematics teacher or experience of not having a good mathematics teacher or unavailability of teacher due to which, they want to become good mathematics teacher and for this, they continued with mathematics. These codes along with their frequencies are shown in the following graph.

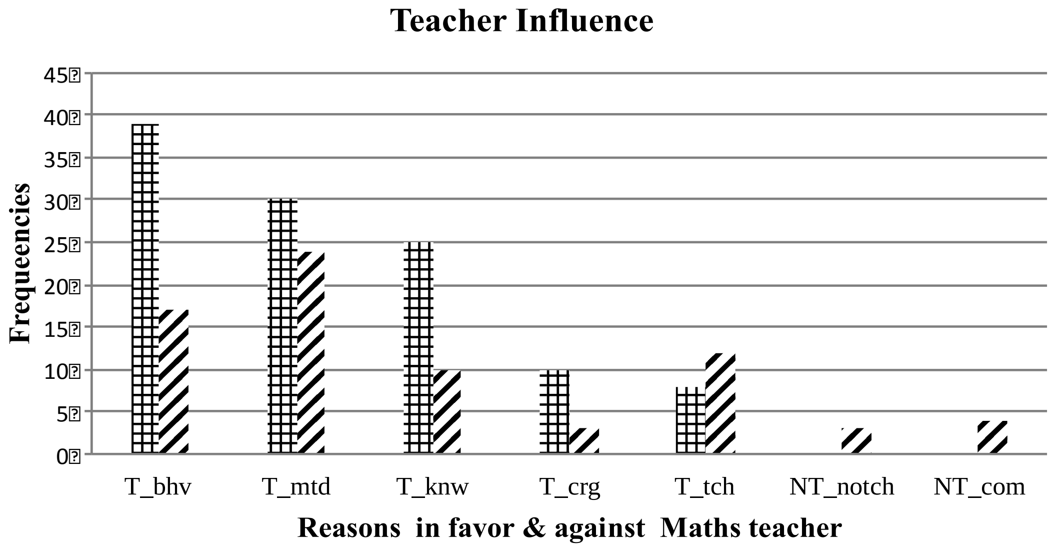

Figure 7.5. Frequency graph of variable codes on Mathematics teacher’s Influence

Whereas, reasons provided as the causes of students’ negative attitudes and avoidance of mathematics were more than those in favour. Mostly mentioned variable was “poor and uninteresting teaching methodology” practised by teacher. Other prominent factor, which is found, is unfavourable or uncooperative behaviour of mathematics teacher in the class. Further, students thought that teachers don’t have enough mathematics content knowledge. In addition, unavailability of mathematics teacher mostly in government schools is another contributing factor of mathematics avoidance mentioned by respondents. Moreover, lack of teacher-student communication and discouraging some students on the basis of their poor progress or under achievements were also indicated, though, these can come under behaviour category but to avoid the complexity and in order to explore more deeply the variables, these were coded as separate variables.

Discussion

Frequency graph, in figure 7.5, clearly indicates that a great number of students are of belief that teacher can inspire or discourage students towards this discipline from his behaviour, teaching methodology and mastery in content knowledge. Respondents mostly used the words of teacher's good behaviour, helping attitude, cooperative & good nature and teaching in friendly environment as the reasons that attracted them towards this discipline. Thus, a teacher is lacking in above mentioned characteristics can make students run away from this subject. For example, in the same premises, causes given by students for mathematics avoidence are; teacher's strict behavior, favouritism in class or teacher's attention towards particular students.

Intervention studies, especially in the cadre of developing mathematical skills, are enriched with teacher's cooperative & helping role and motivating environment (Shayer & Adey, 2002). Results proved that teachers' cooperative behavior produced positive outcome in terms of effective learning and better performance of students. Therefore, possible statements regarding teacher's help & environment would be,

- My mathematics teacher helps me out when I don't understand mathematics or mathematical problem.
- My teacher teaches mathematics in friendly environment.

Some students (18%) mentioned punishment as a major reason for developing negative attitude among students towards this subject and even towards education. In Pakistani government schools, physical punishment, though it is banished at government level but, is still practised by teachers very often. Informal discussions with students and personal observation of the researcher, during the survey-visits in schools, revealed that students disliked mathematics because of their mathematics teacher. Usually students reported that mathematics teacher was strict, instead of helping the student by explaining the concept she or he used to punish the students often physically. Thus, keeping this fact as objective of exploration the cause of negative attitude of studetns in mathematics, following items are constructed,

- My mathematics teacher is strict and I'm afraid of her or him.

- My mathematics teacher punishes me without knowing the reason when I don't do homework (mathematics).

Research, exploring stereotypes, indicates that teacher often interact with few particular students who attract the attention of teacher towards them, either on the base of gender, socio-economic status, intelligence or past performance. In result, those students who fail to become the part of teacher-student interaction may lose interest in class. Following item can examine the student's perception of her or his teacher attitude with him;

- My mathematics teacher doesn't have the same attitude towards all students.
- I feel that my teacher ignores me when I try to talk or ask question in class.

Further, on the base of perception of favouritism or biased attitude of the teacher, following statement may be,

- My mathematics teacher only likes the bright students in the class.
- She or he doesn't allow dull students to sit in the front row of the classroom. Or,
- She or he usually asks bright students to sit in the first row in the classroom.

Moreover, regarding gender stereotypic behaviour, studies in gender differences also reported teachers' gender biased attitudes (Fennema-Sherman, 1981; Gallagher & Kaufman, 2005), therefore, following statement is developed,

- My mathematics teacher thinks that girls are usually not good in mathematics.

About 15% of the respondents reported that students left or they adopt mathematics because no mathematics teacher was available in the schools or didn't find good mathematics teacher (without describing what they meant by "good") or expressed their desire to become good mathematics teacher. Therefore, following statement is generated to know whether in Pakistani schools students still have these sentiments or not.

- I never found a good teacher of mathematics.
- I don't like mathematics because of my mathematics teacher.

- It’s hard to get the mathematics teacher to respect me. (Source: Revised FSMAS)

Whereas in positive sense the same feeling can be inquired through this item,

- My success in mathematics is due to my teacher’s help.

The other most reported reason in coded variables is, teacher’s teaching methodology. Respondents mentioned “boring teaching methodology”, “don’t know how to teach”, “emphasize on getting marks” and “memorizing of formulae rather than imparting the concepts”, “attention focused on solving exercise or completing syllabus rather than providing the practical implications of mathematical concepts”, heavy work load, etc., under this category.

Therefore, keeping in view all these mentioned reasons, possible statements are constructed following statement according to the age of our target population.

- I fail in mathematics because of poor or boring teaching of my teacher.
- My teacher does not re-explain or revise the topic even if someone doesn’t understand once.

Regarding concept formation;

- My teacher starts directly solving the exercise sums without explaining the real concept.
- My teacher emphasizes on memorizing the formulae and steps to solve the questions.

Further work and syllabus completion load,

- My teacher is used to solve some examples and few sums and give us remaining as homework.

And as a positive statement,

- My success in mathematics is due to my teacher’s help.

Furthermore, the coded variable teacher's mastery over content knowledge, students remarked that school teachers possess very limited knowledge of mathematics, or do not have competency on all mathematics domains, and do not impart practical implications of mathematical concepts, thus fails to develop students' interest in mathematics. Therefore, a simple statement depicting the student's perception about the competency of her or his teacher is;

- My teacher has good knowledge of mathematics.
- My teacher explains mathematics concepts in detail by giving different examples.

Regarding real life relevance of mathematical concepts,

- My mathematics teacher tells us the use of mathematical concept in daily life before going to solve sums/exercise.

Last but not least, variable code, "T_crg: teacher's encouragement & motivation" in school was indicated as complementary element to bring the students towards this field of study in later years. Teacher's encouragement for their students is the source of her or his motivation for their students. Thus, what a teacher expects from her or his students can be perceived through the students' perception of their teacher's encouragements towards learning mathematics and motivating behaviour. Teacher's motivating behaviour can be seen through inquiring opinion on the following statement,

- My teacher encourages me to ask questions and to learn mathematics.
- My teacher is interested in my mathematics progress.

Teacher's belief about the learning capacity of the student can be measured through the statements about student's perceptions as,

- My mathematics teacher made me feel that I have ability to do mathematics well.
- My teacher says that mathematics is difficult subject and I can't do it.

Another reason to continue mathematics at graduation and postgraduation level is that, theis school teacher's belief in their mathematical aptitude for future careers. Therefore, the following statements can measure student's perception of teacher's such encouragement, if are communicated,

- My teacher thinks that I can have a good career in science and mathematics related fields.
- My teacher thinks that continuing mathematics in advance level is wastage of time for me.

Items bank for Teacher's Influence Scale

Current data indicate that teacher' influence is significant factor, in which variety of aspects appeared that are needed to study in order to explore significantly influenced variables in the formation of students' attitudes towards learning mathematics. Therefore, to achieve this objective, and convenience in studying deeply teacher's influence on students' mathematics attitudes, this factor is divided into three categories; these are, teacher's behaviour, pedagogical skills & content knowledge, and teacher's encouragement. Following table 7.9 presents the items banks for each factor.

Teacher's behaviour

1. My mathematics teacher helps me out when I don't understand mathematics problem.
2. My teacher teaches mathematics in friendly environment.
3. My mathematics teacher is strict and I'm afraid of her or him.
4. My mathematics teacher punishes me without knowing the reason when I don't do homework (mathematics).
5. My mathematics teacher doesn't have the same attitude towards all students.
6. I feel that my teacher ignores me when I try to talk or ask question in class.
7. My mathematics teacher like only the bright students in the class.
8. She or he doesn't allow dull students to sit in the front row of the classroom.
9. My mathematics teacher encourages me to ask question and to learn mathematics.

10.	It's hard to get the mathematics teacher to respect me.
11.	My teacher does not re-explain or revise the topic even if someone doesn't understand once.

Teacher's pedagogical skills

1.	My success in mathematics is due to my teacher's help.
2.	I never found a good teacher of mathematics.
3.	I don't like mathematics because of my mathematics teacher.
4.	I fail in mathematics because of poor or boring teaching of my teacher.
5.	My teacher starts directly solving the exercise sums without explaining the real concept.
6.	My mathematics teacher tells us the use of mathematical concept in daily life before going to solve sums or exercise.
7.	My teacher has good knowledge of mathematics.
8.	My teacher explains mathematics concepts in detail by giving different examples.
9.	My teacher emphasizes on memorizing the formulae and steps to solve the questions.
10.	My teacher is used to solve some examples and few sums and give us remaining as homework.

Teacher's Encouragement

1.	My teacher is interested in my mathematics progress.
2.	My mathematics teacher made me feel that I have ability to do mathematics well.
3.	My teacher says that mathematics is difficult subject and I can't do it.
4.	My teacher thinks that I can have a good career in science and mathematics related fields.
5.	My teacher thinks that continuing mathematics in advance level is wastage of time for me.
6.	My teacher thinks that girls are not good in mathematics.

Table 7.9. Items bank for the construction of Teacher's influence scale

7.11 Parents' Effect

In literature review, it is observed that parents influence their children's way of thought, educational outcomes, preferences for their lives and careers in many axes like; socio-economic status, motivation, expectation, level of satisfaction, etc. In this preliminary survey, respondents too, provoked parents' influence as a major contributor in developing students' affiliation with mathematics and their perception about their own abilities to learn mathematics. In the preliminary survey data, certain variables were found that parents and other family members in Pakistani society influence students' decisions to adopt or avoid mathematics. Detailed results and discussion are given below.

Coding and Results

Responses given for the first question of the pre-pilot survey questionnaire indicate that major influence that brought respondents towards mathematics was their parents' desire and motivation. This variable is coded as "P_mot" which is responded by 26% of the students and among them 69% of the females as compare to 31% of males affirmed this reason for adopting mathematics. Similarly, variable code "P_bro" represents the presence of brother or other family member already in this discipline or profession, which is another reason to influence the decisions of the students to study this subject in higher studies. It will be pertinent here to mention that most of the females (81% girls of total) reported it as a reason for them to continue mathematics at advance level. These responses revealed a very interesting fact that females, who adopt mathematics up till graduation level, are in fact made their decision under the influence of their family members, especially male members, that also reveals that how much girls are influenced by the will of male relatives (father and brother) in Pakistani culture. This scenario presents quite different picture as compare to western world where students are comparatively free to choose their fields of specialization or careers. In addition, other reason that was mentioned by females only was "no other option was available or didn't want to study Biology" which is coded as "P_fem". As it is mentioned in the previous chapters, that parents from middle class in Pakistan expect their children to choose such disciplines that can be a continuous and secured source of income, especially for girls if they are allowed to continue their higher education, and if parents support them financially along with. Because with mathematics in education field, one can earn her or his livings by teaching in schools & colleges or by private coaching, which may be the reason, because of which, perhaps females mentioned this reason. In addition, parents' help is also mentioned for continuing mathematics, and absence of it can cause avoiding mathematics. Here, in this study, parents' help is assumed as aiding their children in doing mathematics, which is coded as "P_hlp". Following table 7.10 presents the codes of all variable mentioned by respondents.

No.	Parents' Positive Enforcement	Codes
1.	Parents' (especially father) desire & motivation to study Maths.	P_mot
2.	Elder brother was in Maths.	P_bro
3.	Parents' help	P_hlp
4.	No other option available being a female (relied on family source)	P_fem
	Parents' negative effect	
1.	Parents show incapability in Maths.	NP_cpb
2.	Parents' low interest in Maths.	NP_int
3.	Parents' over pressure or expectation to get good marks in Maths;	NP_exp
4.	Parents' or student's low economic status.	NP_ses
5.	Parents' view: Maths is not for females.	NP_str
6.	No help is available from parents or family.	NP_hlp

Table 7.10: Coding of Parents' effect variables

On the other hand, possible causes of discontinuing mathematics under this category are; parents' educational incompetency, and their low socio-economic status, that are coded as "NP_cpb" and "NP_ses". Some students mentioned parents' own lack of interest in mathematics and their stereotypic view are coded as "NP_int" and "NP_str", respectively. Stereotypic behaviour of parents though mentioned by only 4% of the girls but is important to study for the exploring the reasons of low proportion of girls in higher education after school education, as it is mentioned in chapter 4 that, about 50% of the total girls leave education after their high schooling. In addition, there is also the underrepresentation of females in mathematics and engineering field that was discussed in chapter 4. Another interesting variable which was found in the data is, parents' over-expectation to excel competency and over-pressure to get good marks in mathematics from their child that put a bad effect on her or him, and in return, this pressure becomes a cause of negative feeling towards mathematics. These variable codes are shown with their frequencies in figure 7.6 to have an idea of proportion of the respondents mentioning this factor.

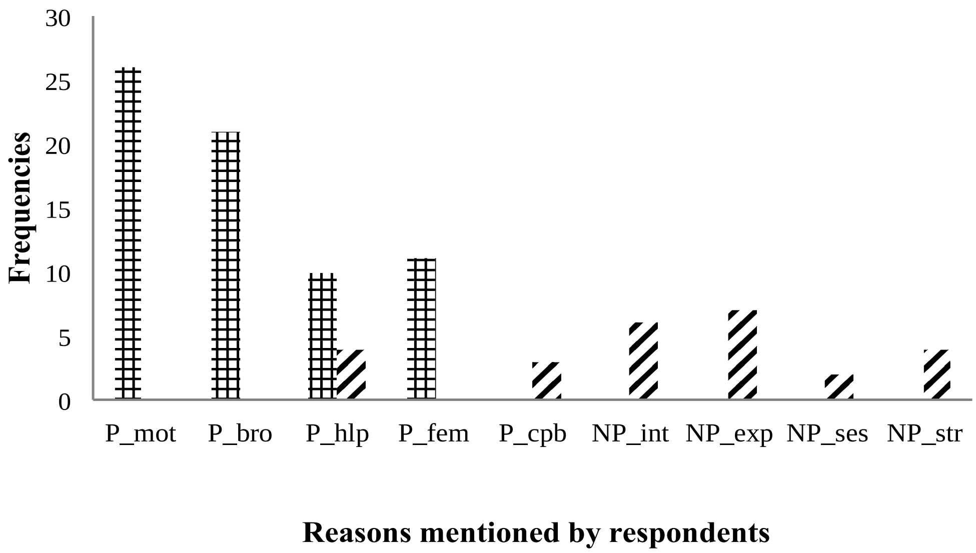

Figure 7.6. Frequency graph of reasons of Parents' effect

Discussion

Comparision of the reasons for adopting mathematics and causes of avoiding mathematics at advance level in the perspective of parents' influence presented in figure 7.6 is made in order to discuss the results and develop the statements in this section.

Parents' help, as indicated earlier, was mentioned both in favour and in against as an influential variable, which is coded "P_hlp" (No help: NP_hlp). Thus, a statement on parents' help on the base of their education level can be formed taking "P_hlp" as a reason of adopting mathematics;

- My parents help me in doing mathematics.

Further, considering the relationship of parents with their children, in the perspectives of communication and trust, and presence of parents or any other family member in this domain (especially mentioned by most of the girls), coded as "P_bro", a statement for school students is constructed,

- I can freely discuss the problems of mathematics with my parents.

And on negative side, along with the idea of gender stereotype, the statement can be,

- My parents discourage me if I inquire about the things.

Moreover, taking income level as the basis of socio-economic status of parents, which is indicated as "NP_ses", this factor can be observed with the parents' help in this statement,

- If I need then my parents arrange tuition or private coaching of mathematics for me.

Facts and figures given in chapter four depict that usually 50% of the girls leave education after their high school education. Therefore, with the contrast of code variable "NP_int" and "NP_str", following items can explore the reason of underrepresentation of females in mathematics too;

- My parents encourage me to get higher education after school.

And for measuring negative influence, the items are;

- My parents think that mathematics is suitable for males not for females.

- My parents expect that their sons should be good in mathematics.

Further, considering the NP_exp variable of parents' expectation, a statement may be,

- My parents make me feel that mathematics is hard and I'm fragile or weak.

Sometimes, over-pressure or over-expectation of parents from their children, which also indicates a sense of dissatisfaction of parents, may develop into negative attitude of students towards mathematics. To examine this aspect, such pressure is measured through two types of statements,

- My parents expect me to get even more, if I already got good marks.
- My parents don't mind if I'm not good in mathematics.

Research affirms that parents themselves transfer their mathematics attitudes to their children as few respondents also indicated in coded variable "NP_cpb". Therefore, following item can be developed in order to observe this effect,

- I heard my parents saying that they were also not good in mathematics.

Items bank for Parents' effect Scale development

Above discussion reveals that coded variables represent different aspects and sources of parents' influence. Therefore, three major categories of parents' influence are explored in this research, which are; Parents' help & Socio-economic status, their expectations, and their motivation. Items under each category are given below :

Parents' help & SES

1. My parents help me in doing mathematics.
2. I can freely discuss the problems of mathematics with my parents.
3. If I need then my parents arrange tuition/private coaching of mathematics for me.

Parents' Expectation

1. I heard my parents saying that they were also not good in mathematics.
2. My parents encourage me to get higher education after school.
3. My parents expect me to get even more, if I already got good marks.
4. My parents don't mind if I'm not good in mathematics.
5. My parents discourage me if I inquire about the things.

Parents' Beliefs

1. My parents expect that their sons should be good in mathematics.
2. My parents think that mathematics is suitable for males not for females.
3. My parents make me feel that mathematics is hard and I'm fragile or weak.

Table 7.11. Items bank for the Parents' effect scale construction

7.12 Students' Self-Beliefs

Students' personal traits have a great impact on their academic achievements. Students' performance in the class or in examinations, where it depends on their mathematical knowledge and concept, there it depends highly on their self-perception beliefs too such as; their self-confidence, conscience, motivation etc. As it is mentioned earlier, that individual's personal traits, her or his beliefs that form his attitude towards learning mathematics, are highly influenced by the home environment where parents play their part in developing her or his self-beliefs, and in school, teacher makes her or him realize that what she or he is and what capacities she or he possesses. Respondents in this preliminary survey have also mentioned few personality traits and past educational achievements that may affect one's attitude towards learning mathematics and her or his wish to continue this discipline in advance studies. Here, first those variables are enlisted that were found in data and then in discussion, collected data is explored in order to develop the statements for the items bank on student's self-perception beliefs.

Coding and Results

Self-perception beliefs play an important role in decision-making process for continuing mathematics. The data collected from the university students in this pre-pilot survey indicate that most of them believed that self-belief of a student in her his capabilities and his mathematics competencies, is a critical variable that push a student towards mathematics and to achieve success in it. However, absence of such belief may detract student's interest in this discipline.

Here, in the data, it was found that 29% of the respondents believe that those students who have perception that they have *strong bases in mathematics*, i.e., they had grip on mathematical concepts, can lead with this discipline in higher studies. Thus, students lacking in such belief may not pursue with mathematics. This variable coded as "S_cncp". Further, previous mathematics achievements are also a variable, which is mentioned by 17% of the respondents as a vital reason to adopt this discipline. Because according to them, those students who fail to attain good marks, usually don't proceed with this subject later. Therefore, this variable can be pertinent to examine in our study, which is coded as "S_mrk".

In addition, belief in one's self "*I can do it*" is also reported to be an important ingredient of positive attitude towards learning mathematics. Fifteen percent of the respondents claimed this variable, coded as "S_cnfd", due to which, they decided to continue mathematics in their graduation. According to them, if student doesn't have belief in her or his self and capacities, she or he can't do well in mathematics.

Other prominent characteristic that a student must have is, *challenge accepting nature* or one can say, "curiosity" that accelerates the probability of taking risk and which is necessary to study mathematics. As quoted by a respondent that "*mathematics offers us challenges*", therefore, one must be ready to face problems. Similar reasons of challenge are mentioned by 20% students, which is taken as a variable and coded as "S_chlng". In addition, student's hesitation is mentioned as a main cause of not taking mathematics as major. In order to have a better understanding of comparison, following table 7.12 shows the variables, explored in the data, with their codes.

No.	Self-Related Statement	Codes
1.	Had strong bases & concepts of Maths in school.	S_cncp
2.	Obtained good marks.	S_mrk
3.	Like to accept challenges	S_chlng
4.	Source of self-confidence.	S_cnfd
5.	To be different from others.	S_dfr
	Traits/experiences	NS
1.	Unclear concepts/gaps in concepts.	NS_cncp
2.	Couldn't get good marks.	NS_mrk
3.	Lack of competitive/challenging behavior.	NS_chlng
4.	Lack of self-confidence.	NS_cnfd
5.	Student's suppositious belief of Mathematics difficulty.	NS_supst
6.	Students' feeling of can't solve mathematics problem.	NS_prb

Table 7.12. Variable codes of self-perception beliefs

Following is given the graphical representation of frequency distribution of the mentioned variables on Mathematics self-beliefs in figure 7.7:

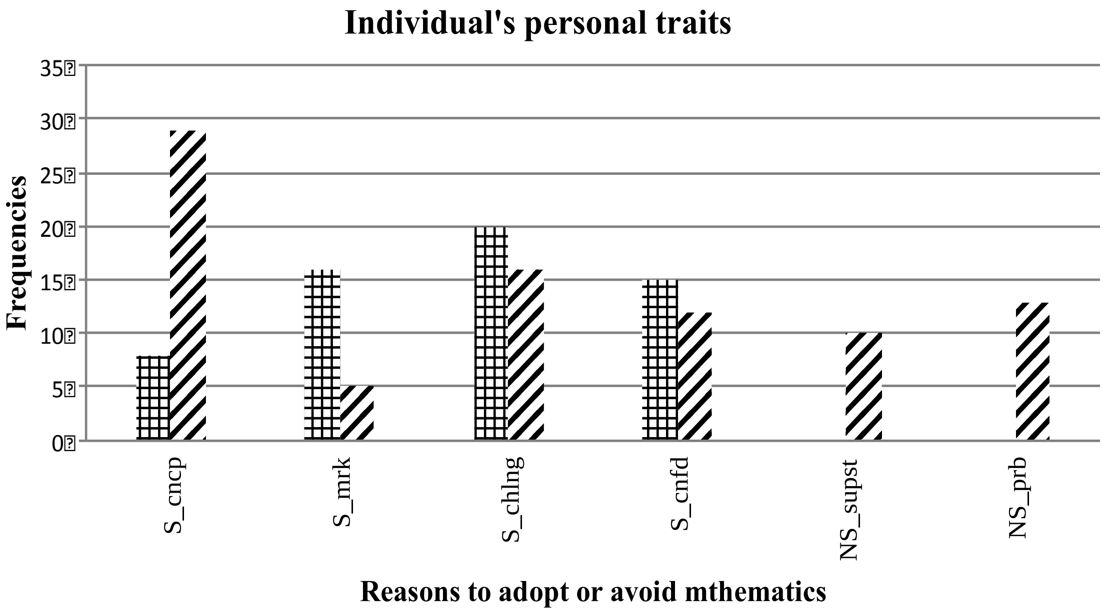

Figure 7.7. Frequency graph for Self-perception beliefs

On contrary, while mentioning further causes of leaving mathematics, respondents mentioned that students' lack of confidence, during solving mathematics problems in the class or during examination, is one of the major causes of mathematics avoidence. This variable that might be due to mathematics anxiety is related to students' belief of incapablity to solve mathematics problems. This variable is cited by 14% of the respondents and is coded as "NS_prb". Further cause of not adopting mathematics is students' superstitious belief, that is, *this discipline is very tough and only those students who are most intelligent can study this subject*. Thus, this variable, coded as "S_supst", represents the suppositious belief of students concerning mathematics difficulty.

In the next section, statements generation process in the light of these results and available related literature is presented.

Discussion

Above frequency results show that different variables related to student's personal traits, mathematical competency, and achievements, are main characteristics that develop in oneself under the influence of social agents and their help. Therefore, statements that will represent student confidence, his beliefs about mathematics in general and his competency in it, are developed in the light of results of current study.

As it is previously mentioned in literature review, that mathematics self-concept deals with person's beliefs in her or his ability in mathematics. While, mathematics self-efficacy concerns with mathematical competency to solve mathematical problem in a given situation, therefore, the phrase "I can" is used in statements that is usually used to express the efficacy belief.

In the above variables discussion, "S_cncp" variable shows student's confidence on her or his mathematics competency that brings her or him towards mathematics. Therefore, to measure this mathematics capability, following statement is derived,

- I can solve mathematical problems with more than one method.

Further, this competency may become a source of motivation to study more, as mentioned by respondents in data. Therefore, keeping this conception in view, following statement is developed,

- I get motivated towards learning mathematics when I successfully solve the mathematics problem.

In addition, to explore the student's excitement and motivation for learning mathematics, a statement can be proposed;

- I am always keen to learn the next coming concept before teacher would deliver it in the class.

Regarding the variable "S_mrk", which depicts that getting good marks is the proof of mathematics intelligence, following statement is exploring such feeling.

- Whoever secure higher marks in mathematics is intelligent.

Moreover, if this sense is combined with students' confidence in his capability as depicted in "S_cncp", a statement, therefore, particularly addressing students' determination, may be formed as,

- I'm sure that I can get good marks in mathematics by working hard.

In addition, students' courage to initiate learning and solving mathematics problems, which can present a collective effect of variables "S_chlng" and opposite effect of "NS_prb" can be observe in the following statement,

- I can solve mathematical problem without seeking the help of others.

Further, with the combination of "S_chlng" and "S_cncp", another item can be generated,

- I can alone do very well in mathematics without my class fellows.

Now taking variable "S_cnfd", a general self-confidence of a student which respondents believed as a necessary agent to understand and learn mathematics, following statements can examine such confidence of the student,

- I feel that my class fellows will laugh at me if I ask any question during period.
- I feel hesitation and fear of asking questions to mathematics teacher during the lecture.
- I am not good in mathematics as compared to other students in the class.

As a positive statement,

- I ask my teacher during lecture if I do not understand the topic.

Students usually avoid mathematics because of the belief that less intelligent students can't excel in this subject, as mentioned by the respondents in variable "NS_supst" too. Therefore, following statement in form of items can explore the level of students' belief.

- Poor performance in mathematics is because of lack of effort.
- Extra effort can bring success in mathematics even if one is not intelligent.
- No matter how hard I try, I cannot understand mathematics (Source: EDGE).

Moreover, respondents mentioned students' belief about the difficulty of mathematics (NS_prb), on the base of which they sometimes couldn't do well in exams and get annoyed from this discipline. Therefore, following belief statements can explore such attitude,

- Mathematics is the most difficult subject for me.

The other way to check this belief may be through this statement,

- Tuition or private coaching is necessary to qualify mathematics exam.

And in positive form,

- I am sure that I can easily qualify mathematics test.

Items bank for Scale development

In the present research study, two mathematics self-beliefs are specified, these are; mathematics self-concept and mathematics self-efficacy. Therefore, generated items which are measured these traits are included in the mathematics self-belief scale. Following table 7.13 presents the possible items for this scale.

1. I can solve mathematical problems with more than one method.
2. I get motivated towards learning mathematics when I successfully solve the mathematics problem.
3. I am always keen to learn the next coming concept before teacher would deliver it in the class.
4. Whoever secure higher marks in mathematics is intelligent.
5. I’m sure that I can get good marks in mathematics by working hard.
6. I can solve mathematical problem without seeking the help of others.
7. I can alone do very well in mathematics without my class fellows.
8. I feel that my class fellows will laugh at me if I ask any question during period.
9. I feel hesitation in asking questions to my teacher during the lecture.
10. I am not good in mathematics as compared to other students in the class.
11. I ask my teacher during lecture if I do not understand the topic.
12. Poor performance in mathematics is because of lack of effort.
13. Extra effort can bring success in mathematics even if one is not intelligent.
14. No matter how hard I try, I cannot understand mathematics.
15. Mathematics is the most difficult subject for me.
16. Tuition/private coaching is necessary to qualify mathematics exam.
17. I am sure that I can easily qualify mathematics test.

Table 7.13. Items bank for the Self-perception beliefs scale

7.13 Other Factors or Stereotypic Beliefs

Responses that were not adjusted in any previously mentioned factors are categorized under other factors or stereotypic beliefs. These reasons mentioned though are very few and mentioned by a small proportion of respondents but it is pertinant to mention and discuss them here in order to have the idea that what are other things that students think might affect students' attitudes towards learning mathematics.

Respondents reffered two reasons in the reply of the first question. Five female respondents mentioned that they adopted this discipline because they think that it is better domain to study, especially for women, to get teaching job. This reason, on the one hand, indicates the fact that few career oppurtunities available for women in this doamin in Pakistani society. On the other hand, it also indicates that there exist societal constraints and hurdles for major proportion of female population in adopting other careers than teaching and medical profession. This may also one of the reasons of underrepresentation of Pakistani women in mathematics related fileds of study. Following table 7.14 presents the coded variables against each reason mentioned under *other factors* category.

No.	**Stereotypic Beliefs & Other reasons**
1.	Good domain for women regarding teaching job
2.	To increase Maths research pool in Pakistan
	Negative influence/stereotypes
1.	Societal behavior creates negative feelings
2.	Inheritance

Table 7.14. Stereotypic beliefs about mathematics

As it can be observed in the mentioned variables for adopting mathematics is, to increase the research pool in Pakistan, which also strengthens the main research objective and cause of the current research in Pakistani context. Eight respondents mentioned that in Pakistan, there are few research oppurtunities in the field of mathematics; therefore, they chose this field of study to contribute in research in mathematics. Following frequency graph in figure 7.8 presents these reasons that were reported as the motivating source to adopt mathematics and causes due to which students run away from this discipline.

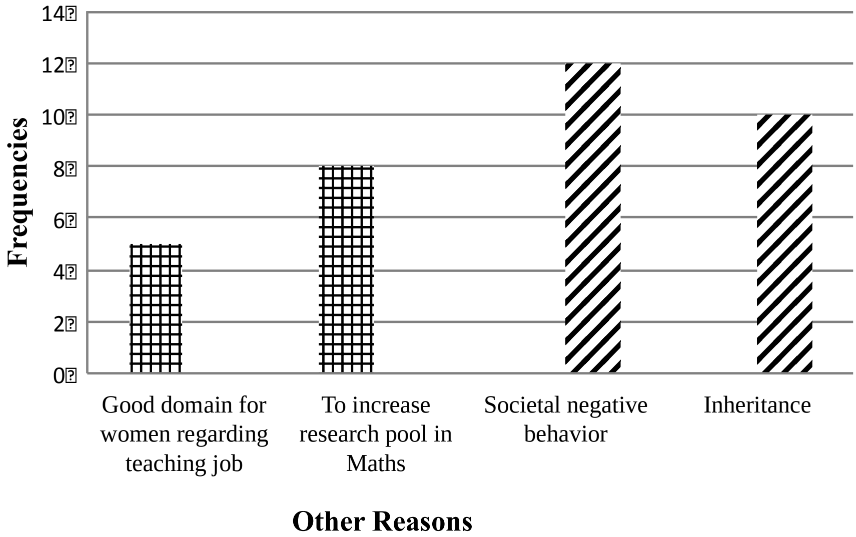

Figure 7.8. Graphical representation of data on stereotypic beliefs

In addition, the causes, of not adopting mathematics, 12 students mentioned that societal behaviour creates negative feeling, though it was not mentioned clearly which behavior but, if it is, too narrowly, taken as prevailed stereotypes then it can be assumed that differences on the base of gender may be the cause of societal negative behaviour. Thus, the resultant feelings may be stated as,

- Careers related mathematics are more suitable for boys.

Lastly, the interesting variable is inheritance factor. Few students (10%) believe that mathematical ability is something like, genes, which are being inherited. In addition, mostly research studies used statements that affirm masculine domination and which is believed to be true in research studies done in biological doamin in 80's, like; "mathematics is male domain". Just, to give a second thought, this viewpoint can be used in reversed form. Therefore, following stereotypic statement can be proposed,

- Girls do better than boys in mathematics.

In relation with this concept we propose a statement to observe the stereotypic belief about mathematics teacher too, which is,

- Female teachers teach mathematics poorly than do male teachers.

Thus, a scale to measure the societal and cultural sterotypic beliefs about "mathematics is male domain" may be:

1.	Careers related mathematics are suitable for boys
2.	Girls do better than boys in mathematics.
3.	Female teacher teachers teach mathematics poorly than do male teachers.

Table 7.15. Items for measurement scale of Stereotypic beliefs

After generating the pool of items for the scales of the current research, the next step is to varify these items through validity process, so that those items, which are measuring or reflect the operational concepts of the mathematics attitude and psyco-social constructs, should be sorted out or refined. To achieve this goal, content validity process is chosen to develop the measurement scales out of these items pools.

7.14 Validity of items

In total, initial pool of 89 items was generated in the light of the preliminary survey results and review of already developed mathematics attitude scales. The basic goal, here, is to screen these items through content validity. The reason to choose this type of validy is that it represents the degree to which elements of a measure instrument are relevant to and representative of the targeted construct for a particular assessment purpose (Haynes et al., 1995, cited in Netemeyeret al., 2003, p.73). Therefore, to ensure the content validity, researcher along with the director of the project and another professor expert in the relevant field verified each item through qualitative procedure. It was taken care that items should be relevant to the theoretical domain of mathematics interest, mathematics belief or other constructs of parents, teacher, self-belief and stereotypic beliefs, and in addition, with respect to the age levels of targeted population. Further, item wording, redundancy, idea of the item, and response format of the scale, and instructions to the respondents were also judged. For example, in our study, mathematics interest has three dimensions, therefore, the content validity was measured of items generated and sorted with respect to their respective dimensions.

After the validity process, the initial pool was reduced to 77 items for the measurement scales for 14 years old students and 74 items for the scales for 11 year old students, which were then distributed in our five scales Once this procedure was done, the next step was to again judge the validity of selected items into Urdu language. For this, researcher along with two professors expert, in this field from Pakistan, judged each item's wording and theme according to its respective construct and modified or trimmed the items where needed. Translated version of Measurement instrument in Urdu are given in the Appendix 2.

The next step in the construction of the measurement scales of attitude is to reduce these pools of items by passing them through the process of reliability and sorting them out into factors within their respective constructs. For this, these scales were needed to administer in pilot test on at least 200 students. The next chapter of this section deals with this stage of the construction of measurement scales.

Chapter.8 Refinement of Research Instrument through Factor Analysis

8.1 Introduction

The main objective of any scale development, especially in social sciences, is to measure theoretical constructs, that is, latent variable, which can't be observed directly. Though our major latent variable is mathematics attitude, but as mentioned earlier, hypothetical model of present research does not assume only one latent variable. Instead this model studies the effect of, and relationship among multiple latent variables within teacher, parents, self-beliefs and stereotypic beliefs' premises, that serve as the causes of generating the mathematics attitude based on mathematics interest and belief. Therefore, within these variables; what are sub variables that are responsible for developing the correlations in the model, are pertinent to explore through scales.

In the previous chapter, items pool is reduced to 77 (74 items for 10-11 years old students) items, which were initially 89 items. This chapter is aimed to refine the initially constructed five scales by exploring the structures of different sets of variables, within each scale, on the base of correlations among them. For this objective, exploratory factor analysis typically using principal component axis technique is used for two main purposes: first to reduce the number of items in each scale by dropping those items which are not satisfying the statistical standards, and secondly, to explore factors or potential dimensions within the scales. To achieve this goal, a pilot study of the constructed scales needs to be administered on a small sample of the students of both age levels 10-11 and 14-15 years old students. Therefore, this chapter deals the research methodology and results of pilot-testing, and in result, refinement of scales for final research instrument.

8.2 Research Design of Pilot Survey

Pilot study that signifies as "*trail runs*" in social science, especially in quantitative research, has its unique importance. Basically "*small scale version*", before conducting original study serves in many ways to achieve several objectives. The most used purpose of pilot study is to check the feasibility of original research, sometimes to check the practical existence and application of research, or to explore the nature of data with respect to the research objectives etc, is also aimed to testify.

However, the main purpose of conducting pilot survey for present research is trying out the research instrument or pre-testing of the initial scales in order to refine them and improve their internal validity. But it will be beneficial for other ingredients of research too like, management of time & resources, assessing the sample of the study, in research protocol designing, etc. Although pilot survey is a small-scaled study, researcher has to pass through all phases of the research like any other original study. Therefore, a proper research design is necessary to elaborate before conducting the pilot survey. Following research design is adopted to conduct the pilot survey for the development of final Instrument of research.

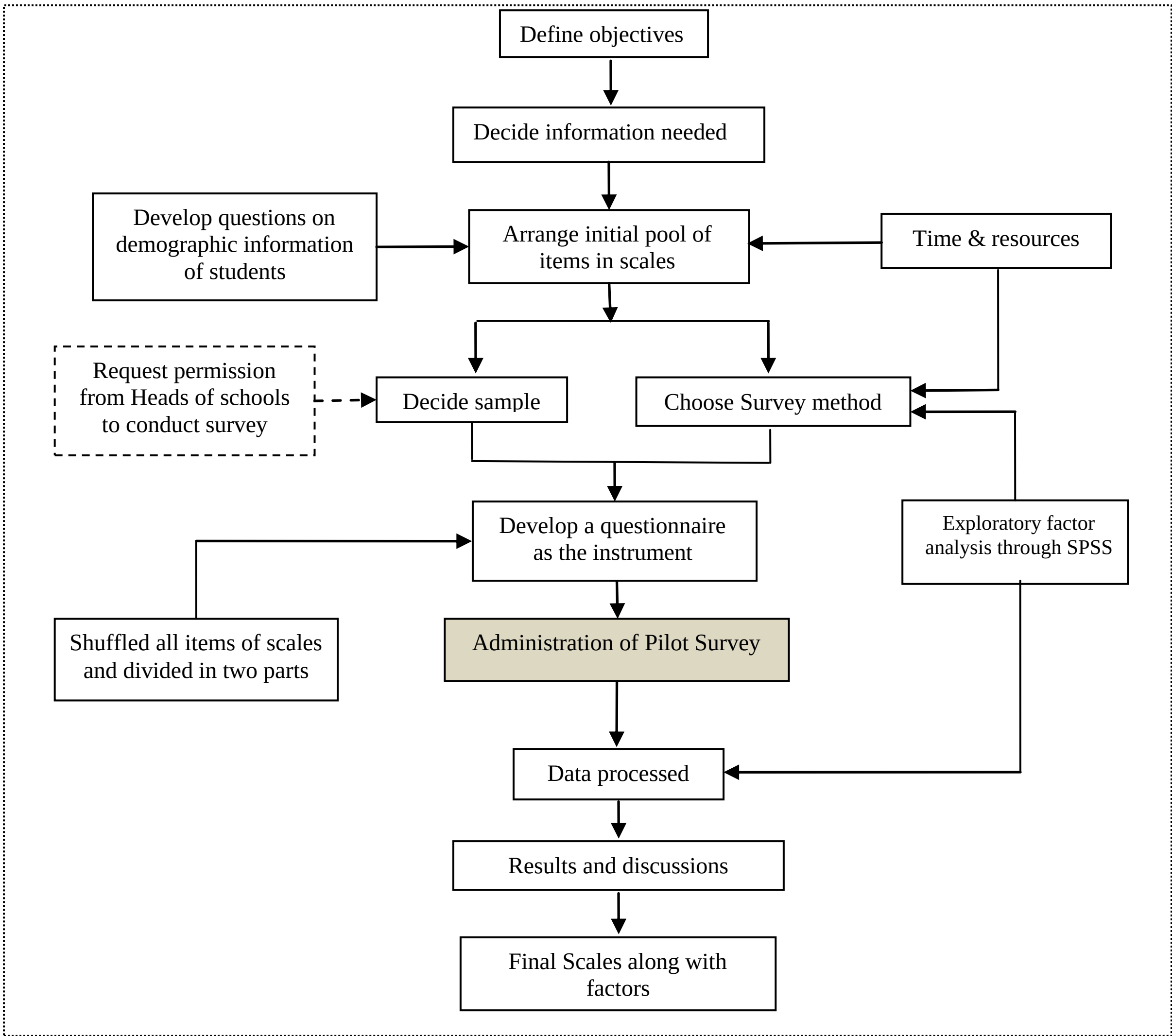

Figure 8.1. Research Design for conducting pilot survey

8.3 Research and Methodology

A quantitative survey research method was used to conduct this study, and for this purpose, a questionnaire based on 5-points Likert's scale was developed consisted of items generated for the research variables in the previous chapter. The details of sampling and research procedures are given below.

8.3.1 Targeted Population

This study is designed to measure mathematics attitudes along with the perception about social and inter-personal beliefs of Pakistani students, especially from Punjab province. As mentioned earlier, in second section, that the reason to select this province is that, half of the Pakistan's population lives in this province. In addition, average literacy rate of this province is higher among all provinces. There are constraints due to which targeted population was selected from this province like; time and financial resources, school access, etc. Therefore, the targeted population for this pilot study was students of public high schools of this province.

8.3.2 Sampling

The sample for this study consists of school students from two age groups of 10-11 years and 14 years. In Pakistani schools, normally students from grade five or six and grade eight or nine falls under these age limits. Therefore, through purposive sampling technique, four schools were selected from three cities of Punjab: Islamabad, Lahore & Sargodha, to conduct this pilot survey. The socio-economic status, literacy rate and culture are significantly different in various parts of Punjab. Thus, for the sake of standardization of this instrument in this province, these three cities were selected on the basis of their different socio-economic level, literacy rate (44% and above) and varied cultures.

Sampling chart is depicting that, two Government Urban schools (FG Sir Sayed Girls School & Islamia Model College for boys) are selected from Islamabad, One government FG girls' school is selected from Lahore and one government Comprehensive boys' high school is selected from Sargodha city. In total, 234 students (121 girls & 113 boys) are selected from grade five and eight of these schools, studying in the last semester of academic years and were aged 10.89 and 13.97 years respectively. The detailed distribution of students' sample is given below:

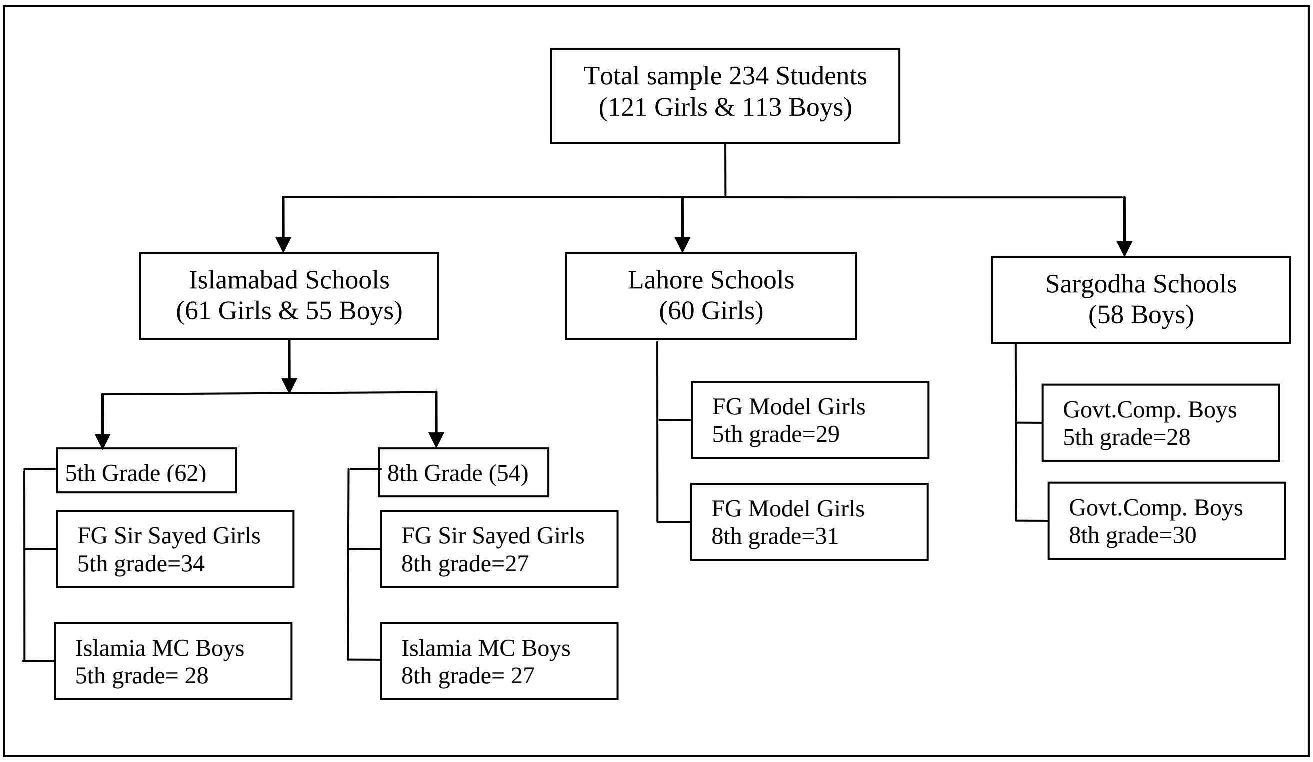

Figure 8.2. : Sample Distribution for Pilot-survey

As far as the sample condition for factor analysis is concerned, that is, number of observations for each item, there are various recommendations that varies from 5 to 10 respondents against each item. For example; Everitt (1975) suggested 5:1 (five respondents for one item), and Nunnally (1978) suggested 10:1 formula. For current pilot survey, at least 6:1 formula is adopted, that is, at least 6 respondents for each item in a scale. Four scales are tested and in each scale the number of items are varied from 14 to 27, thus, the sample of 238 students is justifiable for pilot testing of each scale. Or if pilot testing consisted of two questionnaires is considered (each consisted of 35 and 39 items) then in that case too, this sample size is justifiable.

8.3.3 Instrument of the study

The purpose of this study is to conduct pilot testing of all five constructed scales, which are consisted of 75 items in total. To attempt all scales at a time was not utile according to the standards of research, therefore, two questionnaires are developed, in which, items of the scales were distributed after shuffling. Thus, in first part, there are 37 items (35 items for fifth grade students) and in second part, there are 40 items (39 items for grade five students).

A questionnaire is developed which is consisted of three parts; the first part of the questionnaire is a cover letter for students, in which purpose of the study is briefly described along with the assurance of the confidentiality of their data and request for their cooperation were mentioned. The next section is consisted on the general information, in which their socio-demographic information and about the help regarding doing mathematics are asked. Lastly, the third section is consisted on the items of the scales in which students are provided the instructions to fill them up (Questionnaires are given in Appendix 2).

It was taken care, that students respond to the questionnaire honestly, therefore, their names or identities were not asked in the questionnaire, instead unique serial numbers were printed on the questionnaire.

8.3.4 Administration of Pilot Instrument Survey

As the instrument of the study was consisted of two parts and the pilot survey was to conduct in four schools, therefore, on average two visits in each school were made. Prior to this, as shown in research design too, a formal permission from the principals of the schools or governing bodies was required, therefore, heads of the schools were contacted personally and visited them. Total seven schools were contacted out of which principals from four schools allowed to conduct the study.

Prior the administration of the instrument, in the first meeting with students in all school, researcher introduced herself and purpose of the visit along with the brief introduction of study. During informal discussion, students were assured the confidentiality of their data so that they may get relaxed and mentally prepared to participate in the survey. Approximately 60 to 90 minutes time was allowed for each session and within this time limit, whole procedure was easily managed. As mentioned earlier, that a unique identity number was allotted to each questionnaire, therefore, students were requested to keep that number written in their diaries or somewhere, for next session of pilot-test. In every school, the second part of the questionnaire was administered, on the very next day of the first part's administration.

8.3.5 Data collection and coding

The research instrument for present study is consisted of two major sections; first deals with general information about students, and second one is based on the 5-points

Likert scale. Therefore, numerical coding of each question was required to prepare the data for analysis. There were, in total, nineteen main or sub questions in first section, thus, numeral codes were allotted to each question so that they may deal as variables in the data analysis process. Further, for second section scales, 1 to 5 for level of agreements from "strongly disagreed" to "strongly agreed" was used, and scores were allotted against each selected option.

8.3.6 Data entry and Reverse scoring of Negative-worded Items

Once the data is ready in numerical form on sheets, the other phase comes, that is, data entry in selected data analysis software. In present study, SPSS v.17 software is used for analyzing the data of the study, therefore, softfiles in the program were generated and entered the data after defining our variables for the program.

If there are negative worded items in a scale then there will be negative correlations in the results, though the values remain same, but negative sign sometimes seems cumbersome during analysis. Further, to have high score on the scale to measure certain characteristic in a positive direction then it is necessary to reverse the scores of negative worded statements. As these scales negative worded items, therefore, the scores for such items were reversed. SPSS also provides the opportunity to reverse the scores of the items directly on soft files by two main methods: by formula, and by using SPSS Syntax command. A SPSS Syntax command was used to reverse the scores for the negative items and converted all items scores in the same direction for the facility of analysis.

8.3.7 Issues of Missing Values

It usually happens that some information in questionnaires misses, which may be due to no response for certain questions or sometimes, non-valid response for a question. There may be many reasons for this issue, but how to deal with the missing values or *Gaps* in the data depends on the format of the data and amount of the missing values. Therefore, during coding and scoring it is taken care that those questionnaire which were lacking information more than 20% of the total questionnaire (of Likert's scale portion), should be dropped out from the study[68]. Statisticians proposed some methods to deal with such issues that varies from the case to case, like; allotting a code 9 or 99 to all missing values in the data file, dropping the cases (Listwise or Pairwise), assigning the expected means, etc. As in this pilot

[68] In pilot testing such questionnaires were not more than 3%.

data, the sample is small, further, many cases of gaps were not found, therefore, listwise deletion method is chosen during data analysis.

8.4 Results and Analysis

The major aim of this pilot testing is to refine the constructed scales and testing the hypothesis regarding the relationship among the items in order to extract the factors within each scale. For this purpose, Factor analysis is mostly used technique. Gable & wolf (1993) remarked that, "the purpose of factor analysis is to examine empirically the interrelationships among the items and to identify their existence as a factor or construct to be measured by the instrument" (p.108).

Exploratory factor analysis (EFA) consists of several mathematical procedures through which, a set of items passes to form few factors to measure the constructs. These includes; items correlations, extract number of factors on the basis of percentage of total variance explained in the process of decomposing correlation matrix into set of Eigen values, or extraction of factors on the basis of scree plot or few thumb rules, etc. Further procedures are generating factor loadings matrix and using rotation method to identify the clusters of highly intercorrelated items to form conceptually meaningful factors. There are two types of rotations: orthogonal and oblique rotation. The main difference between these two rotations is that, orthogonal rotation keeps factor uncorrelated, while oblique allows factors to correlate. For present study, VARIMAX with Kaiser-Normalization method was adopted under orthogonal rotation in conducting factor analysis on the sample data. As Exploratory factor analysis (EFA) method seeks two objectives: reduce the number of items and select those which can maximize the explained variance, and *identify potential underlying dimension in a scale* (Netemeyer et al., 2003, p.121). Therefore, certain criterion was needed on the base of which, items could be deleted or accepted. For this research, loadings up to 0.4 or above were decided substantially though different statisticians proposed different levels (0.2-0.9) according to the sample size. For example, Field (2007) proposed loading 0.3 or above to accept an item for the scale for the sample size between 200 and 300. The next standard to test the acceptability of an item for the scale is its reliability value. Cronbach's Alpha measures the internal consistency of the items, thus, it is adopted to check the reliability of an item.

Before proceeding factor analysis, Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) was used to verify initial hypothesis that whether the sample size of survey was suitable to conduct exploratory factor analysis or not. The range of KMO is zero to one, in which, value greater than 0.5 assures the suitability of sample size for conducting factor analysis. Other important thing was the Bartelett's test of sphericity. The null hypothesis under Bartelett's test assumes that the original correlation matrix of the items in a scale is an identity matrix. Therefore, if correlation matrix becomes identity matrix then correlation among variables will be zero. Thus, a significant value of Bartelett's test would ensure the relationship between the variables and such variables would be included in the factor analysis. Therefore, before conducting exploratory factor analysis, it was pertinent to check KMO and Bartelett's test of sphericity to decide whether exploratory techniques was suitable for the pilot data of this study. Following table 8.3 presents the output of the scales of present pilot study:

SCALES	KMO value	Bartlett's test	P
Mathematics Attitude Scale:			
• Mathematics Interest scale	0.783	$\chi^2_{(45)} = 799.68$	< 0.001
• Mathematics Belief Scale	0.772	$\chi^2_{(45)} = 373.84$	< 0.001
Perception of Teacher's Influence Scale	0.833	$\chi^2_{(325)} = 1724$	< 0.001
Perception of Parents' Effect Scale	0.587	$\chi^2_{(55)} = 138.19$	< 0.001
Self-perception beliefs scale	0.709	$\chi^2_{(120)} = 587.76$	< 0.001

Table 8.3. KMO and Bartelett's spericity test for Factor analysis of scales

Since KMO statistics for all scales was found greater than 0.5 in Table 8.3, hence, the condition for an adequate sample size to conduct factor analysis is satisfied. Moreover, values for Bartlett statistic for each scale were also found significant at $p < .001$, which ensured the relationship between the variables. Hence, on the bases of these results, it can be concluded that factor analysis is a suitable strategy for extracting the factors of the scales of present study. In the next part, the analysis of the scale on the base of EFA is presented. First, the main scale to measure the mathematics attitude is presented, in which, it was judged that to what extent the derived constructs of the study represent the assumed dimensions, which are developed in the light of literature review and operational definitions.

8.5 Mathematics attitudes Measurement scale

Mathematics attitude scale was comprised of items measuring constructs of interest in mathematics and mathematics belief. Thus, both constructs are analyzed separately by using principal component axis method in Exploratory factor analysis, in the light of the assumed dimensions and operational definitions. In addition, reliability of items was measured through Cronbach Alpha. Items that have low communalities or do not load after rotation, further, those items which are found below standardized value of alpha, are removed for the final scale. Following is presented the exploratory factor analysis procedure for mathematics belief.

Mathematics Belief Measurement Scale

To measure Mathematics belief, nine items were left after initial validity check. These items were assumed to measure three dimensions of belief. These items were distributed in developed content categories as;

Global usefulness Belief:

MB1: Mathematics is the most important subject among all subjects in school.

MB2: Mathematics is important for the development of the country.

MB3: There is no technology without mathematics.

Intellectual and practical utility belief:

MB4: Mathematics helps in developing a person's mind and teaches him how to think.

MB5: We can spend a good life without using mathematics.

MB6: I don't see the use of mathematics concepts around me, which I study in maths book (10-11 years old students). Or,

School Mathematics has no relevance with real life (for 14 years old students).

MB7: Mathematics is not creative; it's just memorizing formulas and steps.

Personal/financial utility belief:

MB8: One must be good in maths to get scholarship (10-11 years old students). Or,

With mathematics, we can get scholarships or part-time job easily to cover our educational expenses (for 14 years old students).

MB9: We need to do better in mathematics if we want to become famous.

Against these nine items, pilot data are analyzed through principal component axis method (PCA) under EFA. Results are given below.

Exploratory Factor Analysis results for Mathematics Belief Scale

To obtain the number of factors, there are several methods including rules of thumb, for example, method of Eigen values greater than 1, Scree-plot elbow method, substantive interpretation of solution, minimal percentage (50%) of total variance explained etc. In current study, Eigen values greater than 1 method is adopted and when things are not fulfilling the objectives of the study, scree-plot method is consulted too. Table 8.1 presents the results for the Eigenvalues[69] for mathematics belief scale.

	Initial Eigenvalues			Rotation Sums of Squared Loadings		
Component	Total	Explained Variance (%)	Cumulative (%)	Total	Explained Variance (%)	Cumulative (%)
1	2.685	26.855	26.855	1.933	19.328	19.328
2	1.237	12.367	39.222	1.556	16.563	35.891
3	1.045	10.953	50.175	1.478	14.284	50.175
4	.900	9.743	59.918			
5	.813	8.928	68.845			
6	.788	8.655	77.501			
7	.731	7.876	85.377			
8	.660	7.512	92.889			
9	.608	7.111	100.000			

Table 8.1. Eigenvalues and explained variance for the factor items in mathematics belief scale

Total three components are found whose Eigenvalues were greater than 1 in the results of initial factor items in Table 8.1. These three Eigenvalues depict that there are three factors that can be extracted through the principal component axis methods under EFA. Moreover, the total variance explained by these three components is found 50% which satisfies the minimum condition of the factor solution.

At the next stage, to improve the interpretability of factors, in PCA method by selecting the number of factors to be extracted at 3, the solution is rotated in Table 8.2. For rotation, VARIMAX method with Kaiser Normalisation is used and selected loadings of an absolute value higher than 0.4 (this is used in all scales for extracting the loadings[70] of

[69] We presented the Eigenvalues and explained variance initial and after the rotation in this chapter.

[70] Field (2009) suggested loading > 0.3 for sample size greater than 200, while Stevens (2002) recommends loading > 0.4 in general.

factors). Table 8.2 presents the factor loadings along with their respective Alpha values for each item in its respective factor.

Scale	Factor 1	Factor 2	Factor 3	α *if item deleted*
Factor 1 (α=.570) **Perception of Global utility of mathematics**				
MB1: Mathematics is the most important subject among all subjects in school.	.781			.391
MB2: Mathematics is important for the development of the country.	.488			.528
MB3: There is no technology without mathematics.	.405			.437
Factor 2 (α=.592) **Intellectual & practical utility of mathematics belief**				
MB4: Mathematics helps in developing a person's mind and teaches him how to think.		.596		.580
MB5: We can spend a good life without using mathematics.		.702		.572
MB6: I don't see the use of mathematics concepts around me which I study in mathematics book.(for 5th grade students) School mathematics has no relevance with real life.(for 8th grade students)		.724		.544
Factor 3 (α=.512) **Perception of financial utility of mathematics**				
MB8: With mathematics we can get scholarships or part-time job easily to cover our educational expenses.(for 8th grade students) One must be good in maths to get scholarship. (5th grade students)			.834	.468
MB9: We need to do better in mathematics if we want to be praised.			.654	.500
MB7: Mathematics is not creative; it's just memorizing formulas and steps.			-.514	.542*

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
* As Alpha increased therefore, this item is deleted from scale.
** This item is for elder students only, therefore will be considered only in data analysis for ninth grade students.
Cronbach's alpha of total scale = .642 If MB7 is deleted.

Table 8.4. Factor Loadings for three factors of Mathematics Belief under Mathematics Attitude Scale

It can be observed from the table, that there is not great alteration in the presumed distribution of items in three dimensions of mathematics belief scale and the factors extracted after the data analysis. First factor in Table 8.4 is consisted of all three items, which are proposed in the dimension of *perception of global utility of mathematics.* This factor accounts 26.85% of the explained variance with eigenvalue 2.685. Therefore, it can be concluded that this extracted factor confirms respective hypothetic dimension of mathematics belief. Second belief dimension is intellectual and practical utility of mathematics. Second factor, in Table 8.4, confirms the same dimension with three items, all having factor loadings greater than 0.4 and explained 12.36% of variance (eigenvalue= 1.27). As compare to second dimension, there is the item, based on personal fame MB7, that jumped to next factor. The third factor and the third dimension are found same with little change. With the addition of MB7 in the third factor, this factor measures the perception of financial utility and self-recognition of mathematics. All three items are attained the coefficients greater than 0.4 factor loadings but the Cronbach alpha of the third item indicates that deleting this item may raise the reliability of this factor. Therefore, this item is eliminated from the final scale thus keeping two items in this factor. Hence, out of nine items, eight items are left in the final scale distributed in three factors. The overall reliability of the scale measuring mathematics ability construct is measured at $\alpha = 0.642$ and 50% of the variance is explained by these three factors.

In next part scale development procedure of interest in mathematics is presented.

8.5.1 Interest in Mathematics

In previous chapter, to measure the affective component of mathematics attitude, that is, interest in mathematics, ten items are developed. These items assume to be distributed in the following three dimensions.

Psychological state of Situational interest

MI 1: Mathematics problem is like a game to me in which I want to play and win.

MI 2: To do mathematics is fun for me. (5^{th} grade students). Or,

I enjoy studying mathematics in class. (8^{th} grade students).

MI 3: I'm always keen to learn the next coming concept before the teacher would deliver it in the class.

Mathematics is annoying or agreeable

MI 4: Mathematics makes me tense and uncomfortable.

MI 5: I dislike mathematics even if I get good marks in mathematics.

MI 6: Mathematics is dull and boring because we can't explain the things in our own words.

MI 7: Mathematics should not be compulsory subject in school.

MI 8: Mathematics is difficult to understand.

Individual liking & value

MI 9: I like mathematics because we can get good marks in it.

MI10: Mathematics is just to get a correct answer of the question.

Following is given the results of factor analysis for these ten items, which are analyzed through principal component axis method (PCA) under EFA.

Exploratory Factor Analysis results for Mathematics Belief Scale

Following the same procedure as mentioned earlier, the initial factors for the items of interest in mathematics scale from the principal extraction method are computed. Total three factors are found that account for 54% of total variance. Table 8.5 presents the results for the Eigenvalues for mathematics Interest scale.

	Initial Eigenvalues			Rotation Sums of Squared Loadings		
Component	Total	Explained Variance (%)	Cumulative (%)	Total	Explained Variance (%)	Cumulative (%)
1	2.928	29.279	29.279	2.690	26.903	26.903
2	1.494	14.944	44.223	1.483	14.831	41.733
3	1.006	10.057	54.280	1.255	12.547	54.280
4	.915	9.147	63.427			
5	.760	7.599	71.025			
6	.687	6.868	77.894			
7	.643	6.433	84.326			
8	.601	6.012	90.338			
9	.524	5.241	95.579			
10	.442	4.421	100.000			

Table 8.5. Eigenvalues and explained variance for the factor items of mathematics Interest scale

As it can be seen in table 8.5 that three components has attained eigenvalues greater than one. The first component having 2.928 eigenvalue has explained 29% of the total variance. Remaining two components, which are found to have 1.494 and 1.006 eigenvalues, explained 15% and 10% of the total variance respectively. For further verification, scree-plot is also consulted, in the light of the theoretical assumptions for interest in mathematics scale, three factors are decided to extract in the rotation. Therefore, loadings for three factors are obtained in the result of VARIMAX rotation. Later, for each factor, reliability coefficient (α) of items is measured, and then for whole scale also, Cronbach Alpha is computed to measure the internal consistency of the scale. Following table 8.6 presents the distribution of the items in these factors along with their loadings and respective Alpha value.

Scale	Factor 1	Factor 2	Factor 3	***α if item deleted***
Factor 1(α=.570) **Students' perception of enjoyment in doing mathematics**				
MI 1: Mathematics problem is like a game to me which I want to play and win.	.842			*
MI 2: To do mathematics is fun for me. (for younger students) I enjoy studying mathematics in class. (for elder students).	.725			*
Factor 2(α=.562) **Students' values perception and liking mathematics.**				
MI 3: I'm always keen to learn the next coming concept before the teacher would deliver it in the class.		.824		.529
MI 9: I like mathematics because we can get good marks in it.		.557		.507
MI 10: Mathematics is just to get a correct answer of the question.		-.625		.510
Factor 3(α=.743) **Students' perception of mathematics as annoying or agreeable.**				
MI 4: Mathematics makes me tense and uncomfortable.	.443		.697	.733
MI 5: I dislike mathematics even if I get good marks in it.			.692	.702
MI 7: Mathematics should not be compulsory subject in school.			.666	.705
MI 6: Mathematics is dull and boring because we can't explain the things in our own words.			.739	.659
MI 8: Mathematics is difficult to understand.			.704	.685

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Cronbach's alpha of total scale = .741.
* Alpha cannot be calculated

Table 8.6. Factor Loadings for Interest in Mathematics scale under Mathematics Attitude

The first extracted factor loaded two items that measure the state of enjoyment while doing mathematics. Alpha values of these items cannot be calculated due to the constrained of less than three items. The second factor is consisted of three items, representing the perception of value and liking mathematics has attained the Alpha value to .562. Items in this factor are found same as the hypothetical distribution of items for this dimension (mentioned as third dimension of interest). This dimension "individual liking and value" of mathematics interest is based on the items measuring the characteristics of liking. The third factor, whose alpha (α=0.743) is greatest among all factors, is described as the students' perception of mathematics as pleasant domain or agreeable. This factor has loaded the same items as mentioned earlier for the scale of mathematics interest.

Overall the internal consistency of final Mathematics interest scale is measured at α = 0.741 which is found better than the mathematics belief. All ten items are included in the final mathematics interest scale but with a little alteration in the order in first and second factor. An item, that is included on the first dimension of *Psychological state of situational interest,* is loaded in the second factor representing the dimension of *Individual's interest & value* in mathematics.

In study's hypotheses and the operational definitions of the mathematics belief and interest constructs of mathematics attitude (in the first chapter), three dimensions in each construct are assumed and items are generated accordingly to measure these constructs. Similarly, in the final measurement scale of mathematics attitude resulted in the analysis of pilot data, total six factors are extracted, three under each construct. Each extracted factor is measuring the hypothesized dimension of the respective construct. Hence to this end, in the light of these results, the main research objective of construction of mathematics attitude measurement scale for this study has been achieved.

Moving further, the exploratory factor analysis of self-belief measurement scale is presented below.

8.6 Development of Mathematics Self-Beliefs Scale

The items bank is generated in the light of the discussion on preliminary survey data for the development of student's mathematics self-belief scale. This bank was initially consisted of 17 items. For further analysis in order to address our research questions and through insight of literature review, student's mathematics self-beliefs are delimited to mathematics self-concept and mathematics self-efficacy. Therefore, keeping limitations of the present study in view, items are scrutinized and those items, which are qualified on validity measure are selected for pilot testing. Total nine items are selected for pilot testing, among them, one item couldn't attain the factor loading thus is excluded from the exploratory factor analysis. Exploratory factor analysis with remaining eight items is rerun for initial factors solution in Table 8.7.

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	Explained Variance (%)	Cumulative (%)	Total	Explained Variance (%)	Cumulative (%)
1	2.544	31.798	31.798	2.319	28.989	28.989
2	1.417	17.712	49.510	1.642	20.522	49.510
3	.922	11.520	61.030			
4	.778	9.720	70.750			
5	.745	9.310	80.060			
6	.580	7.253	87.313			
7	.534	6.675	93.988			
8	.481	6.012	100.000			

Table 8.7. Eigenvalues and explained variance for the factor items of mathematics self-belief scale

In Table 8.7, total two components are found that obtained eigenvalues more than one though total variance explained by these two components is found at 49.5% but keeping the number of items and objective of the research in view, it is in acceptable range. The first component with 2.544 eigenvalue explained 31.8% of the total variance, whilst, second component with 1.417 eigenvalue explained 17.7% of the total variance. Therefore, on the bases of these results, the two factors are decided to extract. By following the same procedure of rotation under the principal component axis technique, as mentioned previously, factor loading greater than 0.4 for these items are computed along with the reliability measure of each item in Table 8.8.

Scale: Mathematics Self-belief	**Factor 1**	**Factor 2**	***α if item deleted***
Factor 2 (α = 0.798) **Mathematics Self-concept**			
SC1: I cannot do well in mathematics.	.725		.725
SC2: No matter how hard I try, I cannot understand mathematics.	.670		.781
SC3: I feel hesitation to ask question during mathematics lecture.	.633		.751
SE4: I am not good in mathematics as compare to other class fellows.	.670		.742
SE5: mathematics is most difficult subject for me.	.685		.749
Scale: Mathematics Self-belief	**Factor 1**	**Factor 2**	***α if item deleted***

Factor 1 (α =0.635) **Mathematics Self-Efficacy**		
SE1: I can solve mathematics problem without seeking the help of others.	.519	.633
SE2: I get motivate towards learning mathematics after successfully solving the sum.	.839	.263
SE3: I am sure that I can easily qualify mathematics test.	.784	.354

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Cronbach's alpha of total scale = .737

Table 8.8. Factor Loadings for Mathematics self-concept and self-efficacy scales

Between two factors, five items are loaded on to one component, whereas remaining three items are loaded on second factor. By observing the items loaded in first factor, this factor is labeled as mathematics self-concept. While, three items in second factor are demonstrating the student's belief in her or his competencies in mathematics, therefore, this factor is assumed to measure mathematics self-efficacy.

The internal consistency of all eight items is measured with Cronbach's Alpha and found at α = .737, which is quite good level. Further, the respective reliability measures for both factors are also found at good level, for first factor it is fund at α = .798 and for second factor it is at α = .635. Moreover, factor loadings of each item within the factors have attained quite better level; all loadings are ranging from 0.5 to 0.83. In addition, no item has attained higher value of alpha than the overall alpha value of the factor. Therefore, in the light of these results, for final instrument total eight items are derived for the category of mathematics self-beliefs.

In total, study is aimed to derive four scales in the light of our theoretical model: two scales measuring the mediating and outcome variables under the category of endogenous variables, and two under the category of exogenous variables. To this end, two scales measuring mathematic attitude and student's self-beliefs in mathematics are derived, and now in the following part, result discussion for the scale development to measure the parents' influence is presented.

8.7 Perception of Parents' Effect Scale Development

In the light of extensive literature review in chapter two and preliminary survey results by keeping the research objectives of present study in view, parents' influence is delimited to three factors. Total eleven items are generated and distributed in these three factors: students' perception about their parents' help based on their socio economic status, their gender related mathematics beliefs, and their expectations based on ability beliefs about their children. In the initial validity process, two items were dropped and total nine items were left for factor analysis. Following are given the distribution of the items in three proposed factors after validity process.

Parents' financial and educational help

P1: My parents help me in doing mathematics.

P2: If I need then my parents arrange for me a tuition/ private teacher of mathematics.

P3: I can freely discuss the problems of mathematics with my parents.

Expectation of Parents

P4: I heard my parents saying that they were also not good in mathematics.

P5: My parents discourage me if I inquire about the things.

P6: My parents don't mind if I could not get good grade in mathematics.

Perception of Parents' belief (ability)

P7: My parents expect that their sons should be good in mathematics.

P8: My parents think that mathematics is suitable for males not for females

P9: My parents make me feel that mathematics is a hard and dry subject and I'm weak.

8.7.1 Exploratory Factor Analysis for perception of Parents' influence measurement scale

There are total nine items in the parents' influence measurement scale, which are assumed to measure three latent variables as mentioned above. By using Factor extraction through principal component axis method three components are found to have eigenvalues greater than 1, which explained 54% of the total variance. But later using rotation method, it is revealed that item P6 did not loaded. Therefore, by removing this item, initial factors of items computed with remaining eight items. In this analysis too, three components are found that are having eigenvalues greater than one but this time these components together is explaining 56.4% of the total variance. Initial factors of items presented in Table 8.9.

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	Explained Variance (%)	Cumulative (%)	Total	Explained Variance (%)	Cumulative (%)
1	2.240	28.006	28.006	2.160	27.003	27.003
2	1.161	14.515	42.520	1.211	15.143	42.146
3	1.113	13.915	56.435	1.143	14.289	56.435
4	.947	11.838	68.273			
5	.786	9.828	78.101			
6	.707	8.838	86.939			
7	.558	6.977	93.916			
8	.487	6.084	100.000			

Table 8.9. Eigenvalues and explained variance for the factor items of Parents' Influence scale

First component with 2.24 eigenvalue has explained 28% total variance. The next two components are found to have 1.16 and 1.11 eigenvalues have explained 14.5% and 13.9% of the total variance respectively. This factor items solution has confirmed that like our proposed factors, total three factors are to be extracted after VARIMAX rotation in the process of principal component axis method.

In the next step, Varimax rotation under PCA method is applied on these items. The factor loadings against extracted factors are presented in Table 8.10 along with the reliability measure for each item within the factor.

Scale of perception of Parents' Influence	**Factor 1**	**Factor 2**	**Factor 3**	**α *if item deleted***
Factor 1 (α = 0.787) **Parents' financial and educational help**				
P1: My parents help me in doing mathematics.	.519			.624
P2: If I need then my parents arrange private coaching of mathematics for me.	.862			.705
P3: I can freely discuss the problems of mathematics with my parents.	.707			.648
Factor 2 (α = 0.659) **Expectation of Parents**				
P4: I heard my parents saying that they were also not good in mathematics.		.725		.530

Scale of perception of Parents' Influence	Factor 1	Factor 2	Factor 3	*α if item deleted*
P9: My parents make me feel that mathematics is a hard and dry subject and I'm weak.		.741		.639
P5: My parents discourage me if I inquire about the things.		.542		.547
Factor 3 (α = 0.457) **Parents' stereotypic beliefs**				
P7: My parents expect that their sons should be good in mathematics.		-.401		*
P8: My parents think that mathematics is suitable for males not for females.		.771		*

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

Cronbach's alpha of total scale = 0.697.

* Cronbach's alpha couldn't be calculated for item.

Table 8.10. Factor Loadings for perception of parents' influence scale

The first factor that is extracted through rotation is found to load all three items that were proposed for the category of perception of parents' help. Thus, same label is adopted to mention this factor. The Cronbach's alpha calculated for this factor is found to have α = .787 that has mentioned very good internal consistency level for the items of this factor. The second extracted factor has loaded three items and among them, two items are the same as these are mentioned in the proposed factor. The third item, in this factor, is loaded from our hypothesized third factor. Thus, this factor is labeled "Parents' expectation" which measures the students perception of parents' expectation and for which internal consistency is found at α = 0.659. Lastly, the third factor, only two items are loaded on this factor, which are suggested to measure the parents belief of ability of the student regarding gender. For this factor though "α" value is found below .5, which indicates the inconsistency in the factor. This may be obvious, as the two items may be prompted the gender biased sentiments of boys and girls. But for the sake of exploring its relationship with other variables, this variable is selected as a factor measuring parents' stereotypic beliefs.

Therefore, for one of the exogenous variables of this study, three factors are established, which will serve as the exogenous variables under the category of parents for the hypothesized model. In the following part, scale development to measure the perception of the student of mathematics teacher's effect is presented.

8.8 Teacher's Influence Measurement Scale Development

The last scale for this research is the measurement scale of student's perception of teacher's effect. For this scale, in the previous chapter, total 27 items were generated in the preliminary survey and literature review of already developed scales (cf. Fenemma, 1981). Among these items, eleven items are suggested to develop the measurement scale of teacher's behavior, ten items are proposed for teacher's pedagogical skills scale, and six items are generated for the measurement scales of teacher's encouragement. Among all these items, only one item has been dropped in the initial validity measurement process. Remaining 26 items are analyzed for initial factors of items in order to determine the possible number of factors. On the base of eigenvalue greater than one method, six components are found which have eigenvalues greater than one. Total variance explained by these components is estimated at 69%. For having second opinion, scree-plot test is consulted in figure 8.3.

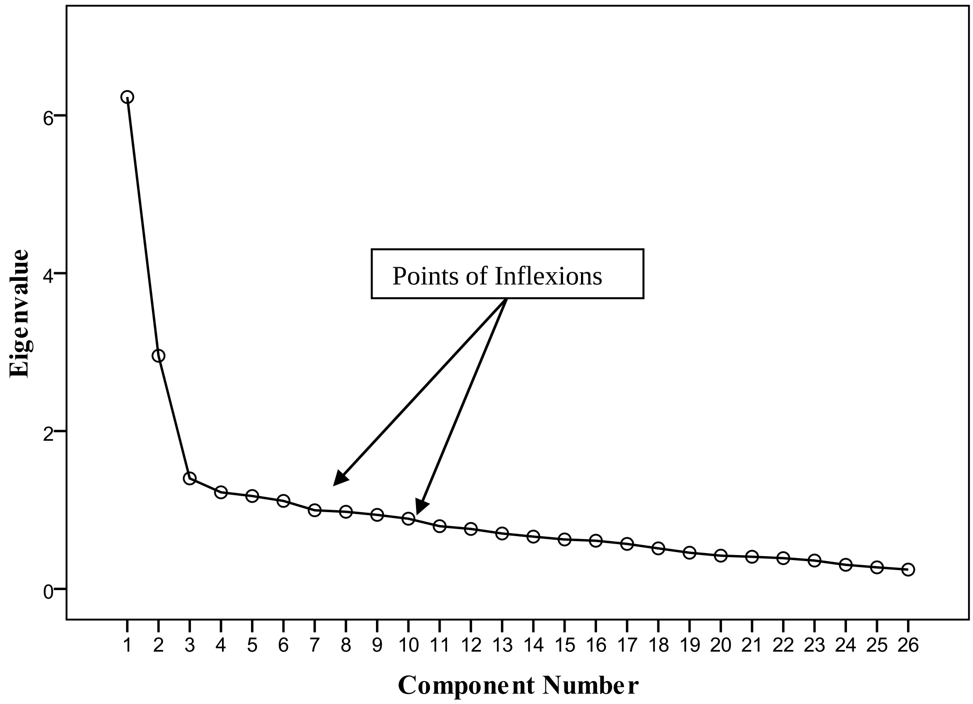

Figure 8.3. Scree-plot for factors of teacher's effect scale

In this scree-plot in figure 8.3, there are two points of inflexions, which suggests three or five components. Though, against three components, 52% of total variance is explained but by keeping in view the research objectives, the option of three factors is selected. At the next step, in order to determine their respective dimensions in which they lay, these twenty six items are rotated with VARIMAX rotation under PCA extraction method by fixing the minimum coefficient at .4 in Table 8.11.

	Factor 1	Factor 2	Factor 3	*α if item deleted*
Factor 1 (α= 0.746) **Teacher's expectation & encouragement**				
TE1: My mathematics teacher encourages me to ask question and to learn mathematics.	.427		.416	0.746
TE2: I feel that my mathematics teacher ignores me when I try to ask question in the class.	.679			0.726
TE3: My teacher helps me when I don't understand mathematics.	.667			0.715
TE4: My success in mathematics is due to my teacher's help.	.521			0.716
TE5: My teacher thinks that I can have a good career in science and mathematics.	.475			0.733
TE6: My teacher is interested in my mathematics progress.	.595			0.709
TE7: My mathematics teacher makes me feel that I've the ability to do mathematics well.	.675			0.709
TE8: My teacher says that mathematics is difficult subject and I can't do it.	.723			0.716
TE9: It's hard to get the mathematics teacher to respect me.	.600			0.734
TE10: Mathematics teacher is strict and I'm afraid of my mathematics teacher.	.574			0.749*
Factor 2(α= 0.633) **Perception of teacher's behaviour**				
TB1: My Mathematics teacher doesn't have same attitude towards all students.		.475	.438	0.631
TB2: My Mathematics teacher teaches in a very friendly environment.		.533		0.629
TB3: My Mathematics teacher doesn't allow dull students to sit in the front row of the classroom.		.474		0.627
TB4: My Mathematics teacher punishes without knowing the reason when I don't do homework.		.461	.452	0.617
TB5: My Mathematics teacher likes only bright students in the class.		.477		0.636

	Factor 1	Factor 2	Factor 3	*α if item deleted*
TB6: Mathematics teacher does not explain again the topic even if anyone doesn't understand.		.595		0.733*
Factor 3 (α= 0.625) **Perception of teacher's Pedagogical skills**				
TP1: My Mathematics teacher explains the concepts in detail by giving examples.			.771	0.598
TP2: My Mathematics teacher solves few questions and gives us remaining exercise as homework.			.634	0.631*
TP3: I fail in mathematics because of poor teaching of the teacher.			.577	0.609
TP4: I never found a good teacher of mathematics.		.422	.516	0.554
TP5: I don't like mathematics because of my mathematics teacher.			.633	0.577
TP6: My mathematics teacher has a good knowledge of mathematics.			.561	0.588
TP7: My teacher starts directly solving the exercise questions without explaining the real concept.			.656	0.568
Total Variance Explained (Eigenvalues)	23.971% (6.233)	18.362% (3.954)	9.517% (1.800)	

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
* Items will be removed from final scale.
Cronbach's alpha of total scale = 0.836.

Table 8.11. Factor Loadings, reliability and explained variance for Mathematics teacher's effect scale

The first component is found with 6.23 eigenvalue and has explained 24% of the total variance. While total variance explained by the other component having eignevalues 3.9 and 1.8 are: 18.3% and 9.5% respectively, in table 8.11. The initial solution with twenty-six items is reduced to twenty-three items after rotation and internal consistency for this scale is measured at α = .836 which is found excellent. As mentioned that there are three factors, proposed in previous chapter, to measure the student's perception of teacher's effect and generated items accordingly. Thus, in Table 8.11, the first factor, which has loaded four items of encouragement factor, is given in Table 7.8. While, two items, 5^{th} and 6^{th}, proposed items couldn't load after rotation, therefore, this factor is assumed to measure the teacher's encouragement (TE). Further, the items TE1, TE2, TE3, TE9 and TE10 that are loaded in this factor are immigrated from the items bank that was proposed for teacher's behavior.

Moreover, TE4 in the same factor, TE is shifted from the items bank proposed for teacher's pedagogical skills in Table 7.8. ten items in total are loaded on this first factor with loading coefficients greater than 0.4. Further, in order to measure the reliability of each item Cronbach's Alpha is computed. The standardized coefficient alpha for this factor "Perception of teacher's encouragement" is found at $\alpha = .746$ which shows an excellent consistency. All items in this factor are found to have less values of alpha than the standardized alpha value except item TE10 ($\alpha = .749$), therefore, this item is dropped for the final scale.

The next factor is labeled as "Perception of teacher's behavior" has loaded six items out of total eleven proposed items in items bank of teacher's behavior in table 7.8. The internal consistency of this factor is found good with $\alpha = .633$, and among all items in this factor the item TB6 is found to have quite high value of alpha as compare to the standardized alpha value. Therefore, it is decided to drop this item though there is another item TB5 whose alpha value was found little more than the standardized value but, in the light of discussion of the preliminary survey results in the previous chapter, it is decide to keep this item on the base of its face validity.

The last factor in the table 8.11 is found to measure the student's perception of mathematics teacher's pedagogical skills. Earlier, in the previous chapter, total ten items were generated for this factor, out of which two items (6 and 9 in Table 7.8) cannot attain the loading coefficient greater than 0.4, thus are dropped, and one item is transferred in factor 1. Hence, seven items are left which are loaded on to this third factor (TP). The reliability measure for this factor is found at standardized coefficient of alpha at 0.625 (good level). All items are retained that standardized coefficient alpha of this factor will decrease if these are deleted except TP2, for which, value is found 0.631. Therefore, this item is removed from the final measurement scale of perception of teacher's effect.

Hence, the final measurement scale of teacher's effect for the final survey contains twenty items, which are aimed to measure three variables. In previous chapter, few social and stereotypic factors were discovered too, reported by the students, that can be adopted as scale too. Below is given the discussion for this scale.

8.9 Stereotypic Beliefs Measurement Scale

The factors that were not adjusted in any scale or category were then developed as a separate category. Total four factors were reported by the respondents, which were then utilized to generate three items. These items in one category were named as the mathematics stereotypic beliefs in Table 7.13. Above, in the Parents' scale in Table 8.10, the factor Parents' stereotypic beliefs regarding gender ability in mathematics is found. Thus, to explore the relationship between the student's perception of her or his parents' view and her or his own belief about the competency in mathematics, this factor is taken as separate scale. In the result discussion of the final survey, this scale measuring students' stereotypic beliefs is named as: "males are best in mathematics". In this scale, an item is measuring the viewpoint of students about the suitability of mathematics and engineering careers regarding gender. Second item is exploring the general view of boys and girls capability in mathematics. Third and the last item is about the expertise of a mathematics teacher to teach mathematics being a male or a female.

8.10 Discussion

In this chapter, for the two main endogenous variables: students' mathematics self-beliefs and mathematics attitude, measurement scales are developed. Within these scales, two factors are extracted under mathematics self-belief and six factors under mathematics attitude. Another scale measuring students' stereotypic beliefs concerning mathematics was also proposed. Thus, by considering this scale too as a factor for mediating variable, student' self-beliefs, has three factors under this category. Further, for two exogenous variables of this study: mathematics teacher and parents; three factors for parents' influence scale and three for mathematics teacher's effect are explored. Therefore, to examine the theoretical model in Figure 2.1, total fifteen variables have been derived measuring different dimensions of the exogenous and endogenous variables. For final survey, this study is delimited to six exogenous variables under the category of social agents, and nine endogenous variables under the students' mathematics self-belief and mathematics attitude categories: in which three are mediating variables and six are output variables. In the next section, the administration of the final survey and analysis of the results to discover the differences among the students is presented. Further, on the bases of these extracted factors, variables of the hypothetical model based on the theoretical model of this study, are measured and the structural models are verified.

SECTION FIVE: DATA ANALYSIS, RESULTS AND DISCUSSION

Chapter.9 Multivariate Analysis of the Data

9.1 Introduction

The main goal of this research was to determine the causal relationships among social and personal factors in the development of student's attitude towards mathematics. Previously in section one, theoretical model is proposed explaining the structure of the formation of mathematics attitudes under the influence of various factors (exogenous and endogenous). Later in the previous section, five measurement scales are constructed to measure mathematics attitude in the light of epistemological framework of the constructs given in first chapter and to measure the influence of concerning factors like; parents, teacher, self-beliefs and stereotype beliefs. These measurement scales were refined in the chapter eight by reliability processes. Then by using Exploratory Factor Analysis (EFA) with Varimax rotation technique on the results of pilot survey, factors were extracted under each scale, and through this procedure, construct validity of the research instrument was also ensured. In total fifteen factors were found in five scales, and those items, which didn't measure the set statistical standards were dropped from the scales.

In this last section of the thesis, consisted of three chapters, research methodology, results, and discussion on the research question are addressed. In this chapter, chapter nine, the idea is quite different from that followed in the previous chapter. This chapter deals with the administration of the final instrument constructed in the result of the pilot studies, and therefore, a final survey is conducted and the research question regarding the differences among the students are addressed. Next chapter is aimed at proposing the hypothetical model based on the extracted factors, which have origins in the proposed theoretical model. Moreover, this hypothetical model is tested statistically on the base of data collected from different schools' students, and further the causal relationships with the moderator of gender, age, and parents' education or occupation (if these are) in the formation of mathematics attitude are analyzed. Lastly, in the eleventh chapter of this thesis, conclusions and discussions are elaborated.

Current chapter deals with two parts, initially it provides the research procedure to collect the data, and later in this chapter, statistical analyses like; descriptive statistics, ANOVA[71], and MANOVA are carried out of the collected data in order to address the research questions of this study concerning differences among the students on the base of their gender, age level, socio-economic status, etc.

9.2 Research Design of Final Survey

In this part of the study, the final survey of the study is conducted in order to explore the research questions and to achieve our research objectives. Thus, an explorative research design is highly needed to conduct this survey. In this design, as it can be observed from the following flow chart of procedural layout in figure 9.1, that the main objective of the study is to explore the causal relationships among the variables. Therefore, refined scales of the study are used as the final instrument for this survey. By following these steps in figure 9.1, this study is aimed to achieve the required results. Detailed design for this study is illustrated below:

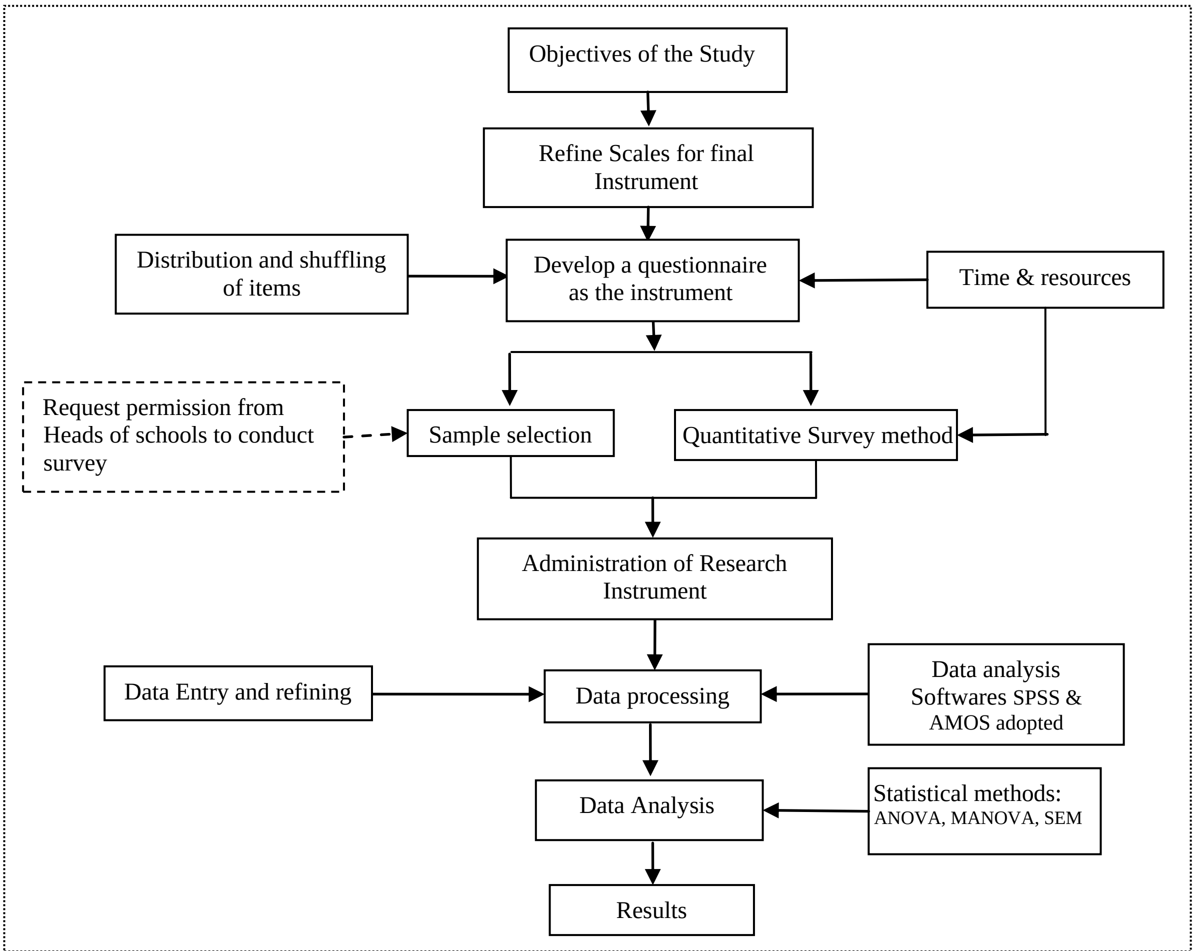

Figure 9.1. Flow of steps in Final Survey Research Design

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[71] Analysis of Variance : ANOVA, & Multiple analysis of variances : MANOVA

9.3 Research procedure

This study is explorative in nature and a quantitative survey methodology is adopted to collect the data. Type of the items used in this instrument has been discussed in previous chapters. Therefore, this chapter proceeds towards the population and sampling for this survey.

9.3.1 Target Population of the Study

During the pilot study, observations revealed us that this study would be more suitable for the students of sixth and ninth grades. There are two major reasons for this decision, one is obviously the age factor with which students' cognition ameliorate, that is, students of sixth grade may be better vigilant than fifth grade students in responding the items of questionnaire. The other reason is that a proportion of students of ninth grade and especially from science group are supposed to be enter in engineering group or may adopt mathematics as major (though students from Non Science group can also adopt mathematics but this proportion is expected to be quite lower than the students from science group). Further, it was assumed on the bases of education statistics in Pakistan that those students (especially girls whose rate of inscription falls to 50% after eighth grade in schools) who join science groups are expected to continue their education in higher secondary school and graduation as compare to other students belonging to other scheme of studies. Therefore, the target population for this study is the students from sixth and ninth (Science group) studying in the schools of Punjab.

9.3.2 Sample of the Study

Two cities of Punjab, Lahore and Sargodha, are selected for the sake of homogeneity of the data. On the base of researcher's personal observation in the schools, and students during pilot study, it was revealed that there is reasonable difference in the socio economic status of students and material facilities in the schools in Islamabad and Sagodha. But regarding Lahore, though there is also the difference as compare to Sargodha, but this difference is comparatively low than that to Islamabad. Thus, for final study we chose schools from these two cities.

To select the sample of the research, a convenient sampling strategy is adopted and contacted eleven public and private schools in Sargodha and seven schools in Lahore.

Among them seven schools from Sargodha and four schools from Lahore city[72] permitted us to conduct the survey in their schools. Regarding the types of the schools, sample consists of total five private schools and five public schools. A total sample of 1547 students participated from these schools in this survey, out of which 48 questionnaires were rejected on the base of incomplete and missing information or outliers. Detailed sampling distribution of students among these schools is given below in Figure 9.2.

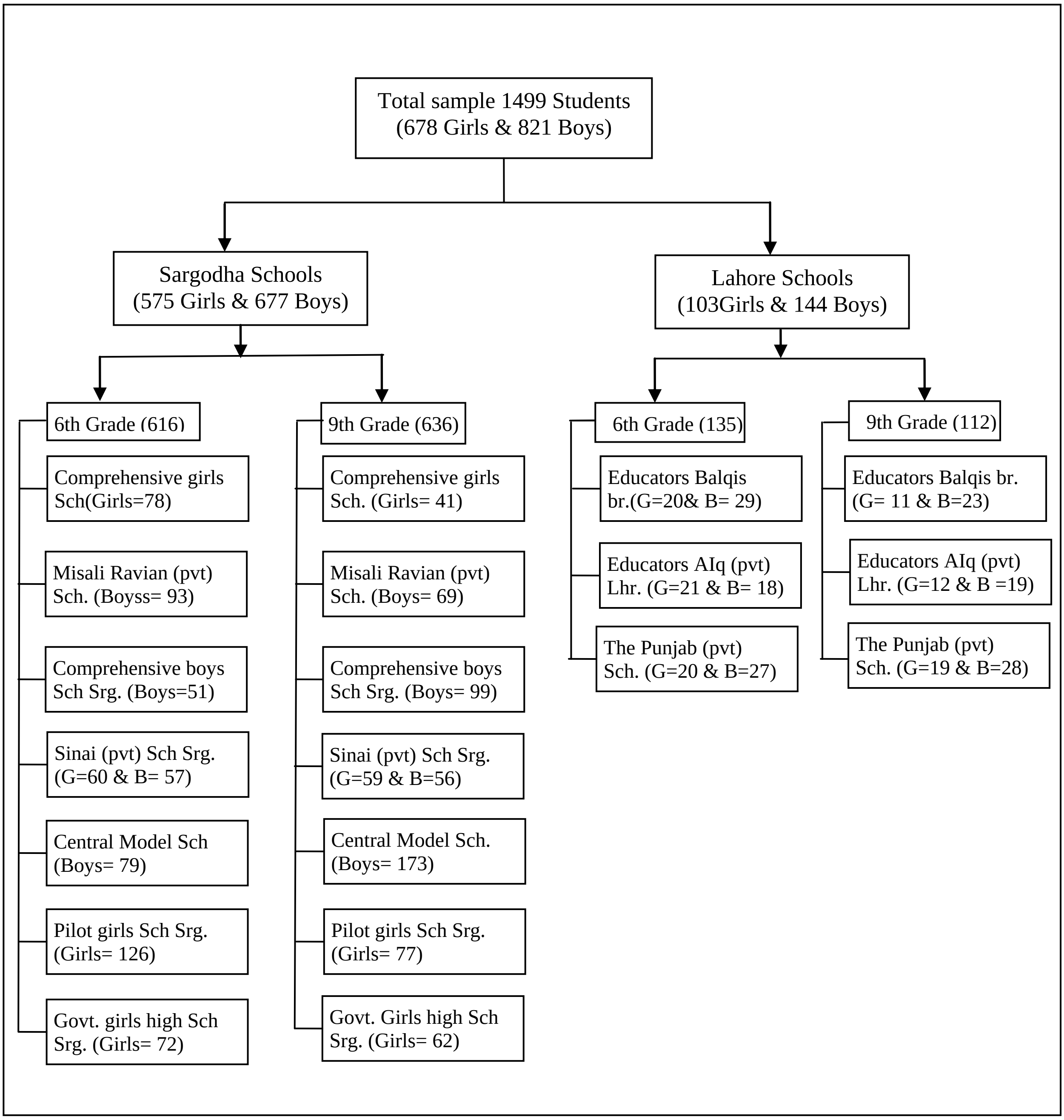

Figure 9.2. Sampling Distribution of Students for Final Study

[72] Later one school was dropped from the study as the students were not available due to their exams in the set dates for the survey.

9.3.3 Instrumentation and Administration of the Research Instrument

This study is in fact a next level of the previous pilot-study, therefore, the procedure of administration of research instrument is almost same as previous. Our instrument, as given in previous chapter, was initially based on 75 items in all scales, which were scrutinized through reliability and construct validity process and reduced to 57[73] items in total. In this final survey, all these items were again reshuffled and distributed in two parts like earlier. In the first part of the questionnaire, there are 24 items along with the demographic information about the student and the second part of the questionnaire is consisted of 33 items. Thus, this survey is also conducted in two parts, and on average, two to five visits were made in each school of both cities.

9.4 Preperation of Data for Analysis

The procedure of data cleaning, entry, editing and recoding of negative worded statements, is explained in chapter 8. In this survey, total 48 (3% of total respondents) questionnaires were found, which were not attempted properly, therefore, these were removed from the final data. Further, missing values, if there were, were dealt with the list wise deletion method as mentioned in previous chapter. Here we will briefly present some descriptive information of our sample of the study.

Descriptive information of the Sample

Sample of the present study belongs to two grades (6th and 9th) and the expected age for sixth grade student is 11 years and for ninth it is 14[74]. Therefore, the data was scanned first in order to drop those students whose ages were outliers of these ranges (above 13years for sixth grade and above 17 for ninth grade). Average ages for students were calculated then and average age for sixth grade students is found at 11.30 years, while for ninth grade students it is 14.30 years.

Education level of parents plays a significant role in children's education preferences, determines their education opportunities and standard of education. In present study, this factor is included as a moderator variable in order to measure its effect on students' self-

[73] Total sixty items were left but three items were removed which were present in the scale for one grade but not in other grade.
[74] In Pakistan, entry age of the student in primary school is five years.

perception beliefs and mathematics attitudes. Following table 9.1 shows few important features of the sample:

		Girls		Boys		Total (total%age)
		N	% age	N	% age	
School	Public	456	30.4%	402	26.8%	858 (57%)
	Private	222	14.8%	419	28%	641 (43%)
City	Lahore	103	7%	144	10%	247 (17%)
	Sargodha	575	38%	677	45%	1252(83%)
Grade	Sixth	397	26.4%	354	23.6%	751(50.1%)
	Ninth	281	19%	467	31%	748(49.9%)
Father Edu level	No education	50	7.4%	70	8.7%	120 (8.1%)
	Primary	116	17.2%	153	19.1%	269 (18.2%)
	High Sch	280	41.5%	334	41.6%	614 (41.6%)
	Higher Edu	228	33.8%	246	30.6%	474 (32.1%)
Mother Edu level	No education	118	17.4%	219	27.2%	337 (22.8%)
	Primary	168	24.8%	200	24.9%	368 (24.8%)
	High Sch	226	33.4%	236	29.4%	462 (31.2%)
	Higher Edu	165	24.4%	149	18.5%	314 (21.2%)
Father's Occupation	No job/died	26	1.8%	69	4.7%	95(6.5%)
	Pvt business (low class)	200	13.7%	187	12.8%	387(26.4%)
	Pvt business (middle class)	288	19.7%	319	21.8%	607(41.4%)
	Govt. job	144	9.8%	186	12.7%	330(22.5%)
	Teaching	9	0.6%	37	2.5%	46(3.1%)
Mother's Job	Yes	89	6.0%	122	8.2%	211(14.2%)
	No	589	39.5%	690	46.3%	1279(85.8%)

Table 9.1. Descriptive Information of the Sample of the Study

For analyzing the data, the education levels of father and mother is divided into four levels and ranked them accordingly, like; 1 = No education, 2 = primary education, 3 = higher secondary school education, and 4 = graduation and above.

9.5 Data Analysis and Results

In current study, there are total sixteen exogenous and endogenous variables along with the socio-economic status of the parents. There are two main exogenous variables: parents and teacher, which are further subdivided into seven variables, four under parents' category and three under teacher category. The main mediated (endogenous) variable of this research study is student' self-beliefs, which are divided into three variables: mathematics self-concept, mathematics self-efficacy and mathematics stereotypic beliefs. Finally, endogenous variable of this study is mathematics attitude, which is measured with two constructs: mathematics belief and interest in mathematics. These variables are further sub divided into their respective dimensions, therefore, under each variable, there are three sub variables.

To proceed further towards the analyses of variance, at this stage, the basic condition of homogeneity characteristics of the sample data is testified, which is given below.

9.5.1 Assumption of Homogeneity of variances

Assumption of homogeneity of the variances of the sample is the basic condition to precede the ANOVA and MANOVA on the refined data. In this analysis, the hypothesis that the variances across the groups in the sample data are same is basically tested, so that means can be compared in order to check the differences among different groups in the data. As this study was conducted on approximately 1500 students, including both boys and girls, therefore, to conduct ANOVA for examining the differences in mathematics attitude regarding gender, if any, the assumption of homogeneity of variances of sample data is examined. For this purpose, test of homogeneity of variances using Leven's statistic is computed. Table 9.2 is presenting the results of the test of homogeneity.

	Levene Statistic	df1	df2	Sig.
Math Attitude	3.848	1	1278	.050
Math Belief	.001	1	1393	.980
Math Interest	6.398	1	1350	.012

Table 9.2. Levene's test of Homogeneity of Variances

In the case of large sample size, like the one this study has (N=1499), the power of the Levene's test improves, and thus, even small differences in variances can result test as significant (Field, 2007; p.150). Therefore, keeping this fact in view, $p < .01$ level of significance (Hamaker, 2009) is chosen for testing the equality of the variances. Results in table 9.2, demonstrate that variances of the groups of boys and girls for mathematics attitude scores are not significantly different, $F (1, 1278) = 3.848$, $p < 0.01$. Though the assumption of homogeneity of variances is satisfied for mathematics attitude but as two constructs to measure mathematics attitude is defined, therefore, it would be pertinent to verify Levene's test for them too. In Table 9.2, results demonstrate that both constructs mathematics belief [$F (1, 1393) = .001$, $p < .01$] and mathematics interest [$F (1, 1350) = .012$, $p < .01$] are also satisfying the condition of homogeneity of variances for both groups of students (boys & girls). Thus, these results assure the computation of analyses of variances on the sample data for examining the differences in mathematics attitude among the groups, as given below.

9.6 Gender Differences in Mathematics Attitude

With the reference to the first question of research that whether gender is a moderating variable in the model of formation of mathematics attitude, first the sample data of current study is explored that whether boys and girls really differ in their mathematics attitudes. For this, the means scores and standard deviations are calculated with minimum and maximum level of scores for boys and girls, which they responded for mathematics attitude and for its constructs in Table 9.3.

	Gender									
	Males					Females				
	N	M	SD	Min	Max	N	M	SD	Min	Max
Math Attitude	685	66.92	9.059	19.00	90.00	595	66.29	9.672	28.00	89.00
i. Math Belief	757	30.38	4.559	8.00	40.00	638	30.53	4.598	12.00	40.00
ii. Math Interest	726	36.51	6.254	11.00	50.00	626	35.86	6.764	14.00	50.00

Table 9.3. Means and Standard deviations of Mathematics Attitude and its constructs' scores by Gender

The mean scores (M) and standard deviations (SDs) values in table 9.3, computed for mathematics attitude and its constructs demonstrate that boys and girls differ in their attitudes, though these differences do not seem very large. Now to decide whether these differences are significant or not, ANOVA is computed in Table 9.4.

		Sum of Squares	df	Mean Square	F
Math Attitude	Between Groups	127.221	1	127.221	1.456
	Within Groups	111706.022	1278	87.407	
	Total	111833.243	1279		
Math Belief	Between Groups	7.475	1	7.475	.357
	Within Groups	29184.009	1393	20.950	
	Total	29191.484	1394		
Math Interest	Between Groups	140.917	1	140.917	3.340
	Within Groups	56951.095	1350	42.186	
	Total	57092.012	1351		

Table 9.4. ANOVA for Gender differences in Mathematics Attitude

These results demonstrate that the differences in the scores for boys and girls are not statistical significant, neither for mathematics attitude, nor for its constructs mathematics belief and mathematics interest. However, these differences, in collective scores, are indicating that boys and girls may be significantly different for the factors of mathematics belief and interest. For this, the sub variables of mathematics belief and interest are tested separately, which is called as level-two analysis.

At level two, firstly for the sub variables of mathematics belief, mean scores and standard deviation of boys and girls are calculated in Table 9.5(a).

	Gender									
	Males					Females				
	N	M	SD	Min	Max	N	M	SD	Min	Max
MB_G Utility	800	11.56	2.254	3.00	15.00	666	11.71	2.204	3.00	15.00
MB_Intlect	789	10.89	2.518	3.00	15.00	654	10.68	2.439	3.00	15.00
MB_Need	801	7.87	1.746	2.00	10.00	672	8.15	1.687	2.00	10.00

Table 9.5(a): Mean scores and SDs of factors of Mathematics Belief by Gender

Mean scores and standard deviations for the factors MB_G Utility and MB_Need are showing superiority of girls over boys for the positive attitude in these factors. Therefore, to analyse the significance of these differences, further ANOVA is computed in table 9.5(b).

Mathematics Belief Sub-variables		Sum of Squares	df	Mean Square	F
MB_G Utility	Between Groups	8.615	1	8.615	1.730
	Within Groups	7290.539	1464	4.980	
	Total	7299.154	1465		
MB_Intlect	Between Groups	16.629	1	16.629	2.699
	Within Groups	8879.687	1441	6.162	
	Total	8896.316	1442		
MB_Need	Between Groups	28.120	1	28.120	9.507**
	Within Groups	4350.874	1471	2.958	
	Total	4378.994	1472		

** p < .01

Table 9.5(b): ANOVA for Gender Differences in Mathematics Belief

Though at level one, any significant differences are not found among boys and girls regarding mathematics attitude and its constructs but results of ANOVA at level 2 are presenting a relatively clear picture. Results for sub-variables of mathematics interest and mathematics belief are indicating that gender is a significant variable for the "MB_Need: maths need belief" factor. This factor MB_Need, which measures belief for mathematics as a source of part time job to earn livings and to be praised, results in Table 9.5(b) prove that boys and girls are holding significantly different attitude for this factor [F (1, 1471) = 9.507, p < .01]. By observing Means scores, it is further cleared that girls (M= 8.15, SD = 1.687) showed more consistent and positive attitudes towards this aspect of the mathematics than boys (M= 7.87, SD = 1.746). Although, girls' mean score in "Global utility belief" of mathematics is also little high but the difference in standard deviations is not enough large to produce significant result regarding gender.

Above, one sub-variable, maths need belief, under mathematics belief in which gender is found a significant moderating variable, though there is no gender difference in the construct mathematics belief. Now to explore mathematics interest, its sub-variables are analysed to examine the gender differences at level two. Mean scores and standard deviations for boys and girls are calculated in Table 9.6(a) for these three dependent variables.

	Gender									
	Males					Females				
	N	M	SD	Min	Max	N	M	SD	Min	Max
MI_Enj	801	7.43	2.043	2.00	10.00	670	7.19	2.272	2.00	10.00
MI_Like	783	11.27	2.223	4.00	15.00	659	11.32	2.280	4.00	15.00
MI_Not Annoy	768	17.72	4.216	5.00	25.00	649	17.36	4.541	5.00	25.00

Table 9.6(a). Means and Standard deviations of Dimensions of Mathematics Interest scores by Gender

In this construct, mean scores for the factor MI_Enj, which measures mathematics interest in the dimension of "enjoy doing mathematics", depicts that boys (M=7.43) are showing little more positive attitude than girls (M=7.19). Further, less SD value in boys' scores is also indicating more consistency in scores than girls. To observe the significance of this difference, ANOVA for these factors is computed in Table 9.6(b).

Mathematics Interest Sub-variables		Sum of Squares	df	Mean Square	F
MI_Enj	Between Groups	20.828	1	20.828	4.503*
	Within Groups	6794.196	1469	4.625	
	Total	6815.024	1470		
MI_Like	Between Groups	.883	1	.883	.174
	Within Groups	7286.857	1440	5.060	
	Total	7287.740	1441		
MI_Not Annoy	Between Groups	45.312	1	45.312	2.375
	Within Groups	26995.330	1415	19.078	
	Total	27040.642			

* p < .05

Table 9.6(b). ANOVA for Gender Differences in Mathematics Interest

Results in Table 9.6(b) are demonstrating that both boys and girls differ significantly for the variable MI_Enj [F (1, 1469) = 4.503, p < .05]. Moreover, mean scores in table 9.6(a) are depicting that boys (M = 7.43, SD = 2.043) are holding significantly positive attitude towards enjoyment aspect than girls (M = 7.19, SD = 2.272). Although for the variable "maths is not annoying" too, boys are showing more positive attitude than girls but this difference is not found significant.

These results, on the one hand, about the first research question of differences in mathematics attitude regarding gender, are showing that boys and girls differ in mathematics attitude, too particularly, for “belief of need” and “enjoyment in doing maths”. On the other hand, these results are also indicating that gender would be an interesting mediator for the model of formation of mathematics attitude under the influence of social factors. Now ahead towards the second research question, sample data is analyse in order to address about the differences of mathematics attitude regarding “age”.

9.7 Difference in Mathematics Attitude with respect to Grades

The second question of the research study is to explore the change in the formation of mathematics attitude across the years. The sample data of this study is collected from the students of two grades belonging to age levels: average ages of 11.30 years and 14.3 years. Therefore, to see that whether mathematics attitude vary across the years when complexity of mathematics also increases in these academic years, and learning capacities of students also enhance, mathematics attitudes is analysed with respect to these two age groups. Through the descriptive statistics for mathematics attitude and its constructs in Table 9.7(a) it can be observed that students of grade 9 are showing relatively more positive attitudes, if mean scores are observed, but the low standard deviations for grade 6 students are affirming more consistency.

	Age									
	6th Grade (11 yrs)					9th Grade (14 yrs)				
	N	M	SD	Min	Max	N	M	SD	Min	Max
Math Attitude	612	66.02	8.127	38.00	87.00	668	67.19	10.32	19.00	90.00
Math Belief	685	30.47	3.992	16.00	40.00	710	30.44	5.079	8.00	40.00
Math Interest	651	35.51	5.977	20.00	50.00	701	36.86	6.892	11.00	50.00

Table 9.7(a). Means and Standard deviations of Mathematics Attitude and its constructs’ scores by Grades

Therefore, to check the statistical significance of these differences, F-statistic under ANOVA is computed in Table 9.7(b).

		Sum of Squares	df	Mean Square	F
Math Attitude	Between Groups	435.459	1	435.459	4.996*
	Within Groups	111397.784	1278	87.166	
	Total	111833.243	1279		
Math Belief	Between Groups	.267	1	.267	.013
	Within Groups	29191.217	1393	20.956	
	Total	29191.484	1394		
Math Interest	Between Groups	615.558	1	615.558	14.714***
	Within Groups	56476.454	1350	41.834	
	Total	57092.012	1351		

* p < .05
*** p < .001

Table 9.7(b). ANOVA for Age Differences in Mathematics Attitude

Results in table 9.7(b) are showing that students of both age groups are significantly different in mathematics attitude [F (1, 1278) = 4.996, p < .05]. By observing mean scores in Table 9.7(a), students of grade 9 (M = 67.19, SD = 10.32) are having more means score than the students of grade 6 (M = 66.02, SD = 8.127). For the sake of careful decision, a t-test[75] was computed for mathematics attitude scores. With t = -2.258, p < .05; it is affirming that grade 9 students are holding significantly more positive attitude towards learning mathematics than that of grade 6. Though, these results are enough to comment that age plays an important role in developing and strengthening positive attitudes towards learning mathematics. However, to explore that where this difference in fact lies, a F-statistic for mathematics belief and interest is calculated too and found that students are actually differ for mathematics Interest [F (1, 1350) = 14.714, p < .001]. While in Mathematics Belief, this difference is not statistically significant. In addition, mean scores in Table 9.7(a) confirming that the students of grade 9 (M = 36.86, SD = 6.892) are showing more interest in mathematics than grade 6 (M = 35.51, SD = 5.977). Further, t-test results are demonstrating that students of age 14 years are holding significantly more positive interest towards learning mathematics than 11 years old students.

Although in Mathematics Belief it is observed that “age” is not appeared as a significant variable, though students differed in mean scores for both age groups. Therefore,

[75] Because levene’s test of homogeneity was failed for mathematics attitude and mathematics belief scores, therefore, Welch and Brown-Forsythe were applied to rebust the means that satisfied the homogeneity of variance for p=.067. Therefore for careful decision, we applied t-test seperatley for each variable.

to explore students' attitude regarding mathematics belief at level two, mean scores and standard deviation and F-statistic for its factors are calculated in Table 9.8(a) & (b).

	Age									
	6th Grade (11 yrs)					9th Grade (14 yrs)				
	N	M	SD	Min	Max	N	M	SD	Min	Max
MB_G Utility	730	11.61	2.015	4.00	15.00	736	11.64	2.429	3.00	15.00
MB_Intlect	713	10.64	2.318	3.00	15.00	730	10.95	2.628	3.00	15.00
MB_Need	736	8.18	1.705	2.00	10.00	737	7.82	1.726	2.00	10.00

Table 9.8(a). Means and Standard deviations of Mathematics Belief scores by Grades

The mean scores in table 9.8(a) are demonstrating the differences among students of both age groups concerning the sub-variables of mathematics belief though mathematics belief as a construct was not found significant. Now before prceeding further, the homogeneity of variances for these variables is analysed. Levene' test was computed which confirmed the homogeneity of the variances for the variables MB_Intlect and MB_Need [F (1, 1393) = 3.94, p = .05; F (1, 1393) = 0.901, p = .343]. Whereas, for variable MB_G Utility, assumption of homogeneity was violated with levene's test, but Welch test, to rebust the equality of means, confirmed the assumption of homogeneity [F (1, 1464) = .109, p = .741; ns]. Now to decide whether there is any significant age difference for these sub-variables, ANOVA was computed in table 9.8(b).

Mathematics Belief	Sub-variables	Sum of Squares	df	Mean Square	F
MB_G Utility	Between Groups	.544	1	.544	.109
	Within Groups	7298.610	1464	4.985	
	Total	7299.154	1465		
MB_Intlect	Between Groups	36.165	1	36.165	5.882*
	Within Groups	8860.151	1441	6.149	
	Total	8896.316	1442		
MB_Need	Between Groups	49.124	1	49.124	16.689***
	Within Groups	4329.870	1471	2.943	
	Total	4378.994	1472		

* p < .05; *** p < .001

Table 9.8(b). ANOVA for Age Differences in Mathematics Belief

It is revealed from table 9.8(b), that students from two age groups differ significantly for the sub-variables “MB_Intlect: Intellectual development” [F (1, 1441) = 5.882, p < .05] and “MB_Need: Maths need belief” [F (1, 1471) = 16.689, p < .001]. However, students of grade 6 and 9 do not differ significantly for global utility belief of mathematics. By observing the mean scores, it can be stated that students of grade 6 showed more positive belief of mathematics need than the grade 9. Whereas, for the variable *Intellectual development* belief of mathematics, these are the students of ninth grade who demonstrated significantly positive inclination. Hence on the one hand, it can be concluded that age is affecting students’ belief about mathematics; with age, students refine their thoughts and appreciate mathematics more as a source for their intellectual development. On the other hand, young students more believe that mathematics is a key to get scholarship and better job, but with moving in advance grades, students decline in this belief, which may be because of the enhancement of perception and knowledge about other sources and ways to fulfil this need.

Although age is found a significant moderator for the Mathematics Interest, but to check the intensity area, that is, in which sub-variables age is significant, mean scores and standard deviations are calculated in Table 10.9(a).

	Age									
	6th Grade (11 yrs)					9th Grade (14 yrs)				
	N	M	SD	Min	Max	N	M	SD	Min	Max
MI_Enj	730	7.03	2.183	2.00	10.00	741	7.62	2.083	2.00	10.00
MI_Like	713	11.16	2.166	4.00	15.00	729	11.42	2.322	4.00	15.00
MI_Not Annoy	695	17.28	4.131	6.00	25.00	722	17.81	4.576	5.00	25.00

Table 10.9(a). Means and Standard deviations of Mathematics Interest scores by Grades

Mean scores for all sub-variables are demonstrating that students of grade 9 are holding comparatively more positive attitudes than the students of grade 6. To explore these differences, homogeneity condition is tested first, which is satisfied for MI_Enj and MI_Like with levene’s test[76] [F (1, 1350) = 3.781, p>.05 & F (1, 1350) = 3.378, p > .05]. after homogeneity condition, data of these sub-variables are analyzed with ANOVA, presented in Table 10.9(a).

[76] But for MI_Not Annoy, homogeneity was violated even with Welch rebust test: F (1, 1409) = 5.052, p=0.024. Therefore, k-independent sample t-test is used for this variable too.

Mathematics Interest Sub-variables		Sum of Squares	df	Mean Square	F
MI_Enj	Between Groups	130.078	1	130.078	28.584***
	Within Groups	6684.945	1469	4.551	
	Total	6815.024	1470		
MI_Like	Between Groups	24.588	1	24.588	4.875*
	Within Groups	7263.152	1440	5.044	
	Total	7287.740	1441		
MI_Not Annoy	Between Groups	96.198	1	96.198	5.052*
	Within Groups	26944.445	1415	19.042	
	Total	27040.642	1416		

* p < .05; *** p < .001.

Table 10.9(b). ANOVA for Age Differences in Mathematics Interest

The results for ANOVA are demonstrating that students of both age groups are holding significantly different attitudes in all factors of “Mathematics Interest”. These results of all F-values are affirming that with growing age, students develop their mathematics interest more significantly in all three dimensions; “enjoy doing maths” and “liking in maths” [F (1, 1469) = 28.584, p < .001 & F (1, 1440) = 4.875, p <.05, respectively]. While for the variable though F-value is showing a significant value but for more careful conclusions, a t-test was computed. The t-value [t = -2.252, p < .05; sig] is depicting that the students of grade 9 demonstrate significantly more interest regarding the variable “maths is not annoying” than the 6^{th} grade students.

At the threshold of these results, in the response of the first and second research questions, it is found that, students, both boys and girls, differ in mathematics attitude for its different dimensions. Further, these attitudes get refine and strengthen with age; more girls than boys appreciate *Need belief* of mathematics, whereas, more boys than girls enjoy doing mathematics. In addition, grade 9 students demonstrated more *liking in mathematics* and *intellectual development* belief than grade 6 students, while, later hold more positive belief in *Maths Need*.

Now moving further to explore that, how these differences among boys and girls are affected by age or grade level, and what kind of changes happen in their mathematics attitudes, the third research question, data are analyzed through cross interaction of gender and age, given below.

9.8 Gender differences in Mathematics Attitudes across the Age

Previously, differences among the students are observed in their attitude towards mathematics regarding their gender and grades separately. This part deals with the third research question, that is, do boys and girls differ in mathematics attitude across the age? To see the effect of age on gender in the formation of mathematics attitude, boys and girls from both grades are compared with respect to mathematics attitude and its constructs by using MANOVA technique on the sample data. Therefore, this issue is studied in two parts, first it is tested that whether interaction of gender and grade is significant or not. Later, the effect of this interaction of gender and grade is studied on mathematics attitude and its constructs, and then for the six variables of mathematics attitude. To verify the significance of the interaction between the gender and grade, Lambda in multivariate analysis (also Pillai's test etc.,) is computed in table 9.10(a).

Effect		Value	F	*df* Hypothesis	*df* Error	Sig.
Gender * Grade	Pillai's Trace	.022	4.660	6.000	2552.000	.000
	Wilks' Lambda	.978	4.672	6.000	2550.000	.000
	Hotelling's Trace	.022	4.683	6.000	2548.000	.000
	Roy's Largest Root	.020	8.303	3.000	1276.000	.000

Table 9.10(a). Multivariate analysis of Gender and Grades interaction

The results of Wilks' Lambda test (other tests; Pillai's Trace, Roy's Largest Root etc., too) in table 9.10(a) clearly depicts that the null hypothesis that, there is no between-groups differences with respect to grade and gender is rejected, [Wilks' Lambda = 0.978; $F(6, 2550) = 4.672$, $p < .001$]. Thus, it can be concluded that the gender differences among the students are significant at both grade levels.

Now to explore the effect of gender and grade interaction on students' mathematics attitude, a series of MANOVAs are conducted, first with three dependent variables (mathematics attitude and its two constructs), taking grade or age and gender of the student as independent variables. Later, the combination of six variables (three under Mathematics Belief and three under Mathematics Interest) is chosen as dependent variables, and two independent variables; age and gender. At first stage, Table 9.10(b) is presenting the effect of students' gender and grade interaction with respect to mathematics attitude and its constructs.

Dependent Variable	*df*	*df* error	F	Grade	Gender	Mean	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Math Attitude	3	1276	2.056	6	Male	66.062	64.955	67.169
					Female	65.982	64.986	66.979
				9	Male	67.494	66.590	68.398
					Female	66.693	65.550	67.836
Math Belief	3	1276	1.734	6	Male	30.277	29.738	30.817
					Female	30.828	30.342	31.314
				9	Male	30.637	30.197	31.078
					Female	30.058	29.501	30.616
Math Interest	3	1276	5.058**	6	Male	35.785	35.017	36.553
					Female	35.154	34.462	35.845
				9	Male	36.856	36.229	37.483
					Female	36.634	35.841	37.427

** $p < .01$

Table 9.10(b). Effect of Age on Gender in the formation of mathematics attitude

In previous ANOVA analyses, it is revealed that when the gender is ignored that, whether the student is male or female, grade of the student influences her or his mathematics attitude. However, when grade factor is ignored, gender of the student does not appear significant regarding mathematics attitude of the student. Here in this multivariate analysis, results in table 9.10(b) show that grade of the students does not have significant effect on the gender of the student in the formation of mathematics attitude [F (3, 1276) = 2.056, p=.104]. This means that gender difference in mathematics attitude is not significant across the grades.

Now to explore more deeply that, how boys differ in mathematics attitude across the age or grade level, and what change in girls' attitude towards mathematics happens across the years, their mean scores of mathematics attitudes with respect to gender are plotted in figure 9.3 (a).

As it can be observed in figure 9.3(a) that mathematics attitude of students is enhanced with moving in upper grades. Though, both boys and girls are strengthened in their positive attitude towards learning mathematics in ninth grade as compare to sixth grade's students, but this increment is more widened for boys than girls. Double head dotted arrows are mentioning the differences between two age groups (blue dotted line shows difference in attitude for boys while brown represents the difference between girls' groups).

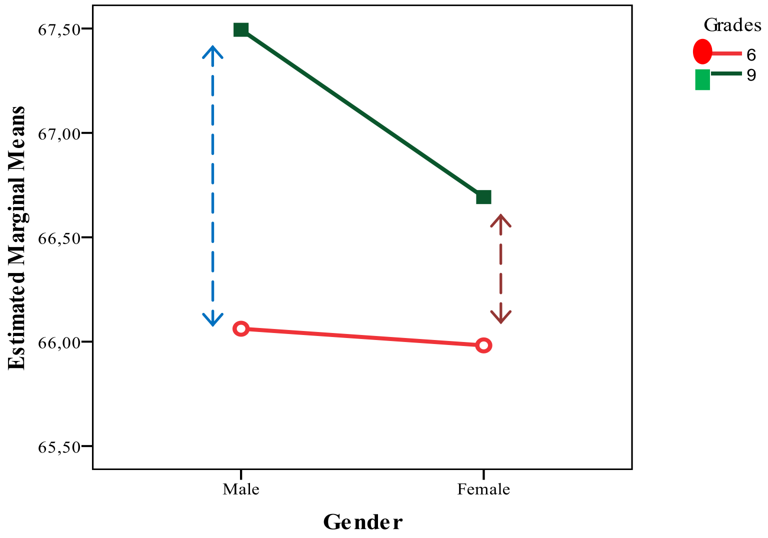

Figure 9.3(a). Comparison of gender with respect to grade in Maths Attitude

Another look of this change in attitude is presented in figure 9.3(b) to understand the differences among boys and girls from grade six to nine.

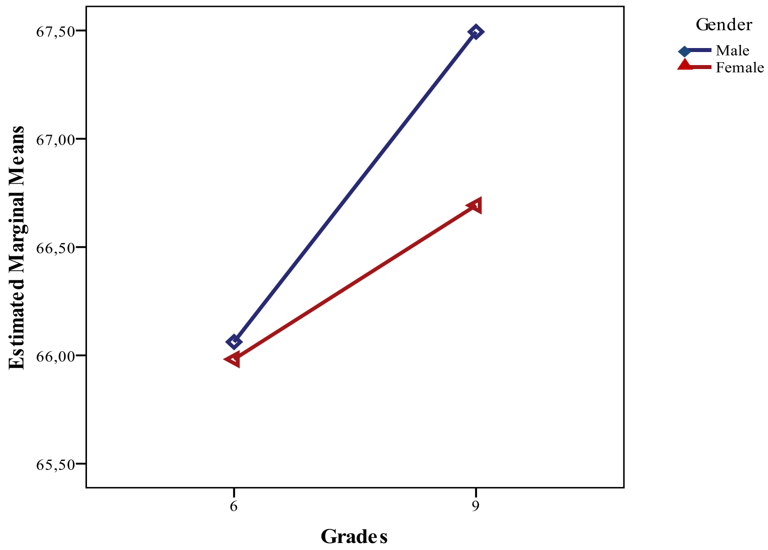

Figure 9.3(b). Comparison of age with respect to gender in Maths Attitude

The difference in mathematics attitude among boys and girls, which is narrow in 6th grade, has widened in 9th grade (Red line is representing the change among girls of two grades and blue line is showing the difference among boys of two grades).

Similarly, as construct of mathematics attitude, students, neither by grade nor by gender, were found significantly different in previous ANOVA results for mathematics belief. Here, too, the effect of grade and gender interaction on the development of the mathematics belief is not found significant [F (3, 1276) = 1.734, p = .158].

The intensity of effect of age on gender in mathematics belief is shown in graph 9.4(a).

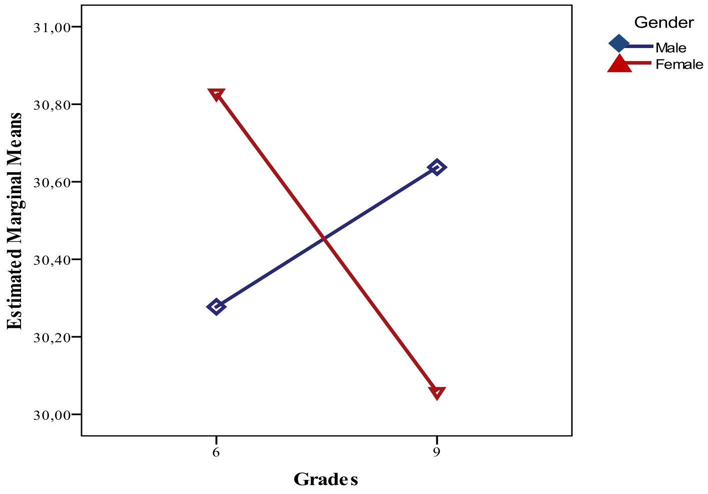

Figure 9.4(a). Comparison of age with respect to gender in Maths Belief

This figure 9.4(a) reveals that boys of 6th grade are holding comparatively low mathematics belief than girls of the same grade. However, this relationship gets inverse in 9th grade; girls declined in their mathematics belief, whereas, boys improved their mathematics belief. In other words, it can be stated that with the increase in age, boys ameliorate in their mathematics belief, while girls decline, but this age difference for the boys and girls of 6th grade does not appear statistically significant from the boys and girls of 9th grade.

However, in mathematics interest, previous results of ANOVA revealed that students of two grade levels were significantly differ in mathematics interest when gender was ignored. But no gender difference was found for this variable, keeping grade as constant. In multivariate analysis, the output in table 9.10(b) depict that effect of grade in developing mathematics interest was different for males than it was for females [F (3, 1276) = 5.058, p < .01].

Regarding mathematics interest, for which difference among the groups is found significant, figure 9.4(b), is presenting the scenario of this difference for both boys and girls from both grades.

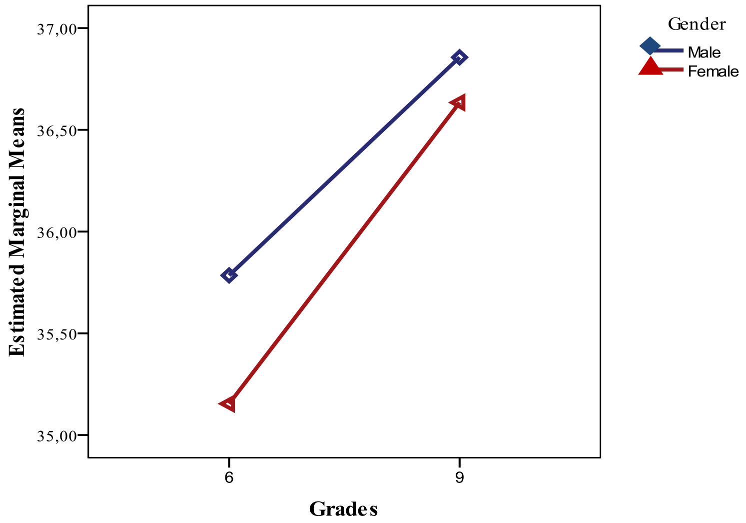

Figure 9.4(b). Students' Comparison with respect to gender and grade in Maths Interest

As we can observe from the figure 9.4(b) that the difference among boys and girls which are widened in grade 6 (0.6 unit) has considerably narrowed down in grade 9 (0.2 unit) and this gender difference across the grades is statistically significant. However, girls showed comparatively low interest attitude in mathematics than boys at both grades.

Hence to this end, it can be concluded that attitude of both boys and girls towards mathematics change with age and this gender difference is significant between the grade six and nine students, in which ninth grade students are holding more positive attitude than the grade six students.

In the following part, relationship of gender and grade is studied with three dependent variables (sub-variables of mathematics belief): global utility belief, intellectual development belief, and mathematics need (financial & self) belief.

9.8.1 Effect of Gender and Grade interaction for the factors of mathematics belief

Above, the effect of age in the formation of mathematics belief was not found significantly different for boys and girls. But whether this is true for all dimensions of mathematics belief? The data for three sub-variables of mathematics belief is analyzed. In this part, multivariate analysis is conducted on three dependent variables (MB_GUtility, MB_Intlect and MB_Need) and two independent variables (gender and grade) in Table 9.11.

Dependent Variables	*df*	*df* error	F	Grade	Gender	Mean	95% Confidence Interval Lower Bound	Upper Bound
MB_G Utility	3	1391	.450	6	Male	11.536	11.290	11.783
					Female	11.723	11.494	11.952
				9	Male	11.625	11.416	11.834
					Female	11.693	11.425	11.960
MB_Intlect	3	1391	7.229***	6	Male	10.483	10.210	10.755
					Female	10.793	10.540	11.046
				9	Male	11.234	11.003	11.465
					Female	10.541	10.245	10.836
MB_Need	3	1391	7.409***	6	Male	8.006	7.818	8.194
					Female	8.329	8.154	8.503
				9	Male	7.784	7.624	7.944
					Female	7.870	7.667	8.074

*** p < .001

Table 9.11. Effect of Age/Gender interaction on the factors of mathematics Belief

The results of multivariate analysis in Table 9.11 reveal that gender and grade interaction is found to be non-significant in one variable only, that is, global utility belief [F (3, 1391) = .450, p = .717]. By observing mean scores and the graph in figure 9.5(a), it is found that both boys and girls from both grades are showing approximately same level of global utility belief of mathematics.

In Figure 9.5(a), it seems that though girls are declining and boys are increasing in this belief from 6th grade to 9th grade but this change from grade 6 to 9 is significant neither for girls nor for boys. The second dependent variable is MB_Intlect in the Table 9.11 for which F-value [F (3, 1391) = 7.229, p < .001] is very significant.

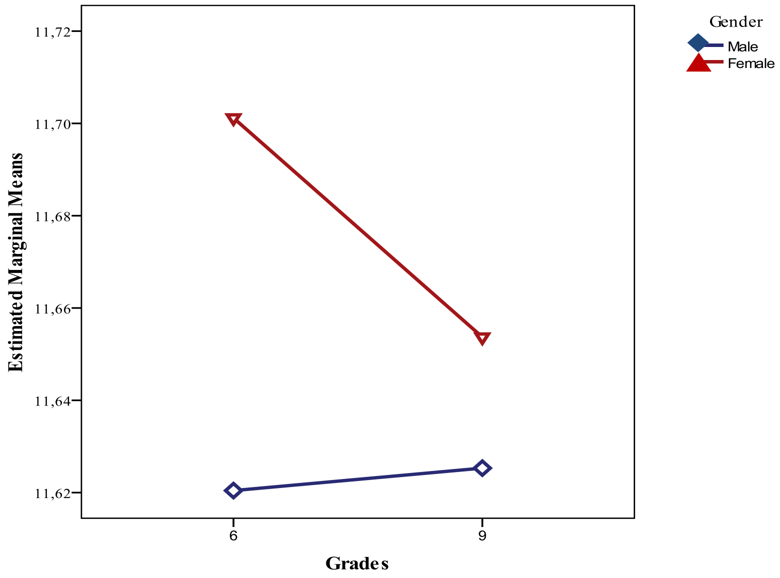

Figure 9.5(a). Students' Comparison with respect to gender/grade in MB_G Utility

This indicates that moving in advance grades affects students' mathematics belief of intellectual development differently for boys than girls. Plotted graph for students' means in Figure 9.5(b) is presenting an interesting situation. The gender difference is significantly more widened in grade nine than grade six. Girls in grade six demonstrate little better belief than boys but girls are declined in intellectual development belief in advance grades. Whereas, boys are improved in their belief that mathematics is the source of intellectual development. The slope of boys' line is significantly steeper and improved than the girls' line.

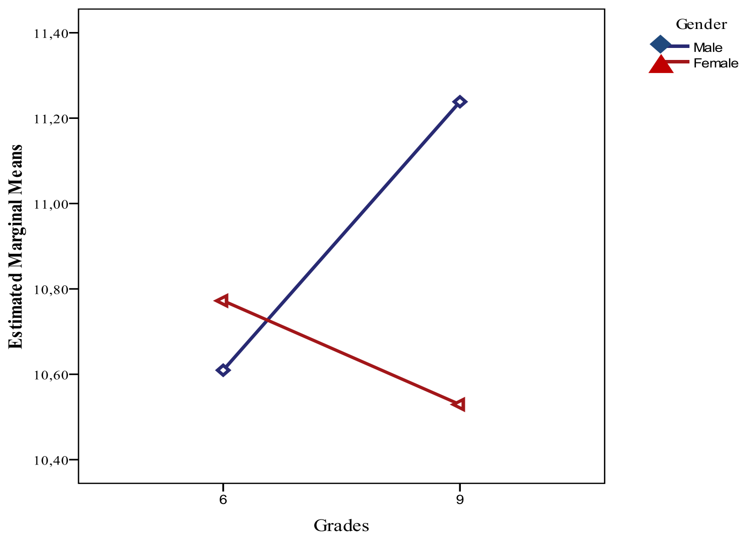

Figure 9.5(b). Students' Comparison with respect to gender/grade in MB_Intlect

The results for third dependent variable MB_Need under mathematics belief, in Table 9.11, demonstrate that interaction between the effect of grade and the effect of gender is significant [$F (3, 1391) = 7.409$, $p < .001$]. The graph is plotted for the estimated marginal means of boys and girls from both grades in Figure 9.5(c), which shows the direction and intensity of the effect.

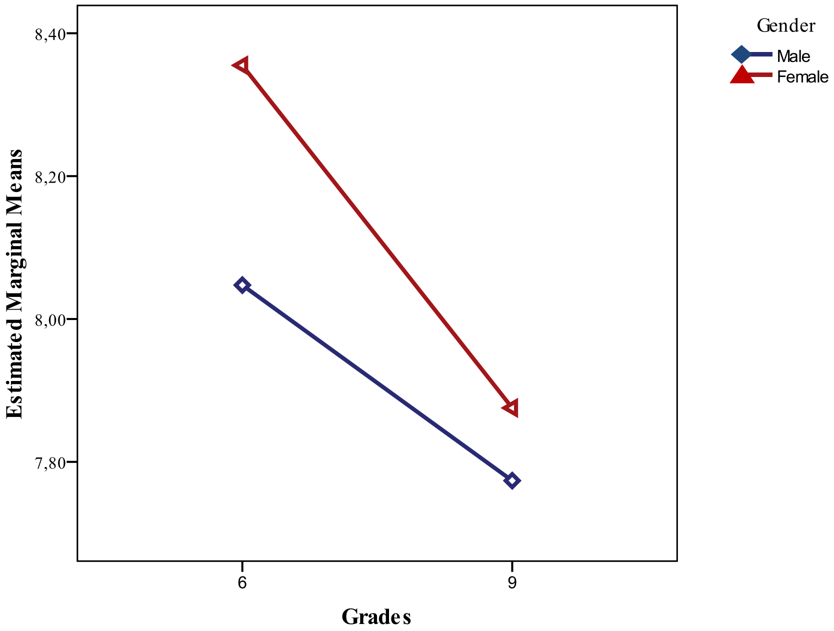

Figure 9.5(c). Students' Comparison with respect to gender/grade in MB_Need

On contrary to Figure 9.5(b), the figure 9.5(c) regarding the variable MB_Need is demonstrating that the gender difference, which is wider in grade 6, significantly is narrowed down in grade nine. However, the downward slopes of the gender lines are showing that this belief that, mathematics is the source of satisfying the *financial and to be praised* need, is declining with age, which is also mentioned in earlier ANOVA results.

9.8.2 Gender and Grade interaction for the factors of Mathematics Interest

In mathematics interest, in previously ANOVA analysis, gender difference was not found significant, however, students differed significantly when analysed grade wise. Later, in multivariate analyses in Table 9.10(b), it is observed in the light of effect of interaction of gender and grade, that grade level effects students' mathematics interest differently to boys than to girls. Now in this section, this issue, in terms of sub-variables of mathematics interest, is studied to explore that where this difference raise significantly. Multivariate analyses is computed on three sub-variables of mathematics interest as dependent variables

(MI_Enj, MI_Like, and MI_Not Annoy), and two independent variables grade and gender in Table 9.12.

							95% Confidence Interval	
Dependent Variables	*df*	*df* error	F	Grade	Gender	Mean	Lower Bound	Upper Bound
MI_Enj	3	1348	12.79***	6	Male	7.290	7.047	7.533
					Female	6.804	6.584	7.024
				9	Male	7.603	7.403	7.803
					Female	7.724	7.470	7.978
MI_Like	3	1348	2.175	6	Male	11.218	10.964	11.473
					Female	11.145	10.915	11.376
				9	Male	11.330	11.121	11.540
					Female	11.582	11.316	11.848
MI_Not Annoy	3	1348	2.419	6	Male	17.348	16.847	17.849
					Female	17.271	16.818	17.724
				9	Male	18.014	17.602	18.426
					Female	17.407	16.883	17.930

*** p < .001

Table 9.12. Effect of Age on Gender in the formation of Mathematics Interest

The F_values, in Table 9.12, clearly demonstrate that only one dependent variable MI_Enj is found where the effect of interaction of gender and grade is significant [F (3, 1348) = 12.79, p < .001]. This means that influence of grade level on “enjoying doing mathematics” is significantly different for girls than it is for boys. This situation can be further illustrated by plotting mean scores of students.

Figure 9.6(a) is demonstrating level of mathematics interest in terms of enjoyment for the students of grade 6 and 9 with respect to their gender.

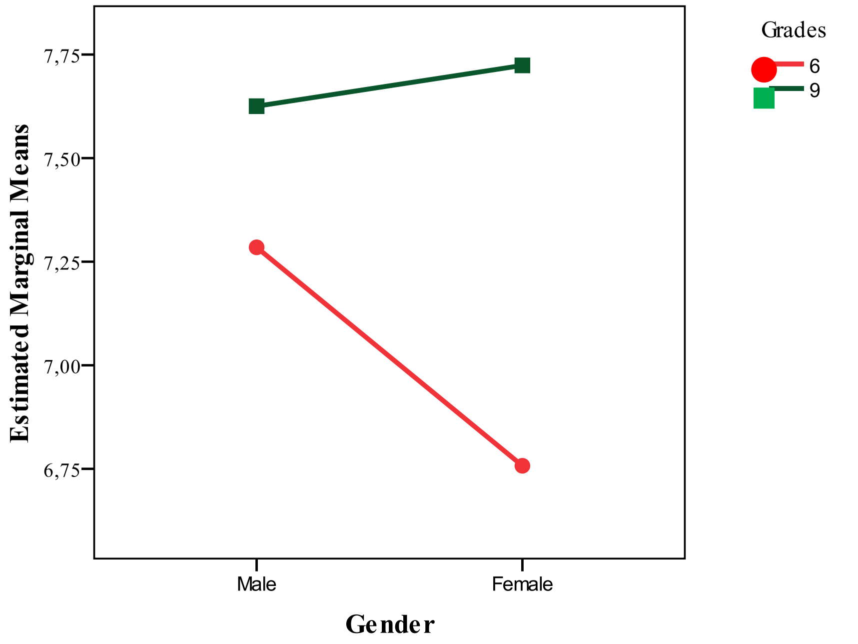

Figure 9.6(a). Students' Comparison with respect to gender in grade in MI_Enj

In grade six, boys are showing better level of interest in mathematics for the factor MI_Enj than girls. On contrary in grade 9, girls rose in their level of enjoyment little more than boys of the same grade but this change is considerably better than girls of grade 6. From this graph, it can be concluded that advancing in upper grades is affecting more positively the girls' level of enjoyment than boys. This situation is studied from another angle too. Figure 9.6(b) is representing the variation among boys and girls from grade 6 to 9.

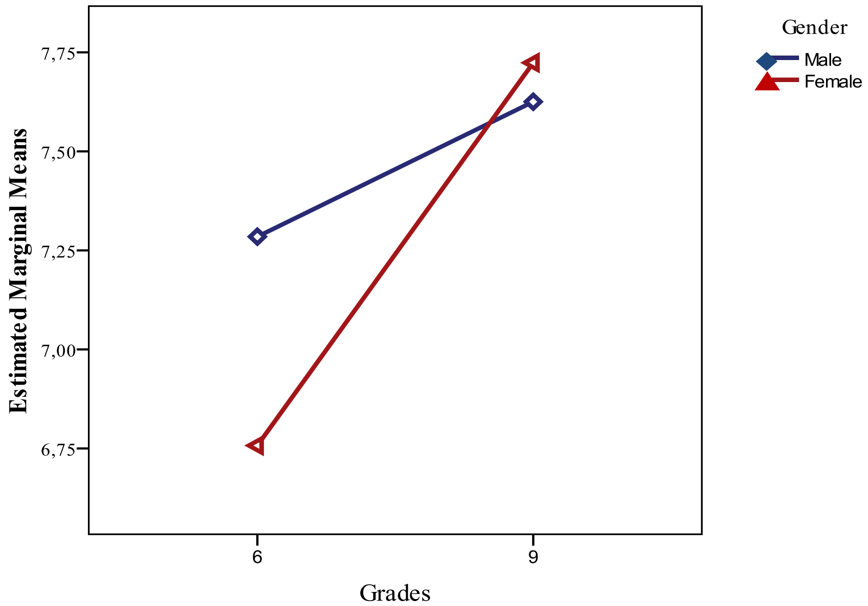

Figure 9.6(a). Students' Comparison with respect to grade in MI_Enj

In figure 9.6(b), the gender difference in sixth grade is wider than that of ninth grade. Further, it can be concluded that with moving in upper grades, gender difference narrows down for appreciating the pleasure of doing mathematics, which is positive effect of grade and gender interaction on mathematics interest.

Moving forward towards MI_Like, in Table 9.12, the gender and grade effect is not found significant for this variable [F (3, 1348) = 2.175, p=0.089]. This indicates that appreciation of mathematics, in terms of liking this subject, does not alter for boys and girls from one grade to other grade. In previous ANOVA results, no significant gender difference was found for this variable, but students were significantly different with respect to age in their MI_Like attitude. Therefore, to observe the difference among the students regarding this variable in the light of grade and gender interaction, their means are plotted in figure 9.5(c).

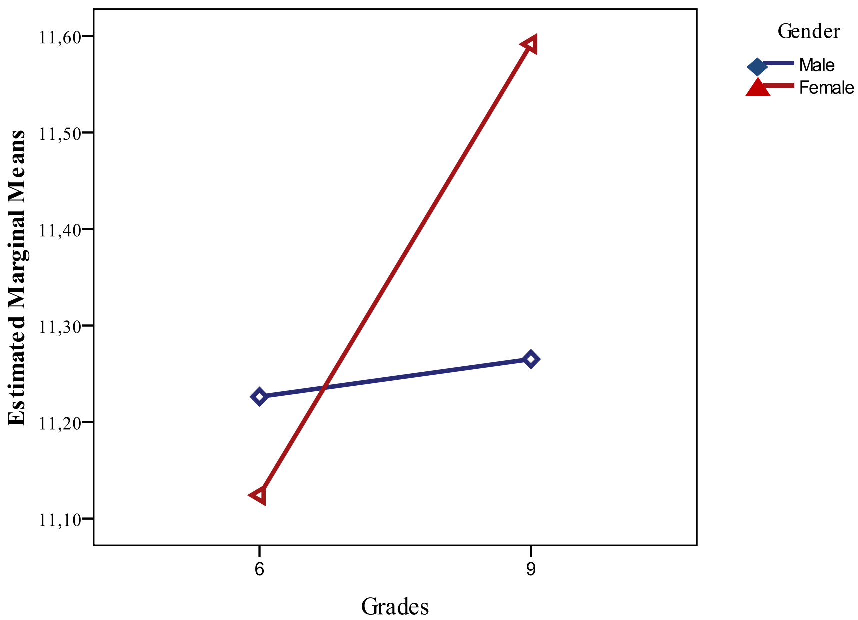

Figure 9.5(c). Students' Comparison with respect to gender/grade in MI_Like

Here in figure 9.5(c) the plotted lines of estimated marginal means are depicting that the difference in mean scores of students for MI_Like from grade 6 to 9 though increased but is very small and non significant.

The last dependant variable in this cadre is MI_Not Annoy for which F-value [F (3, 1348) = 2.419, p = .065] is not found significant. Thus, it can be said that effect of grade level on the Mathematics attitude based on the feelings that mathematics is not annoying is not different for boys than it is for girls. To observe the direction of the change, the mean scores of students are plotted in Figure 9.5(d).

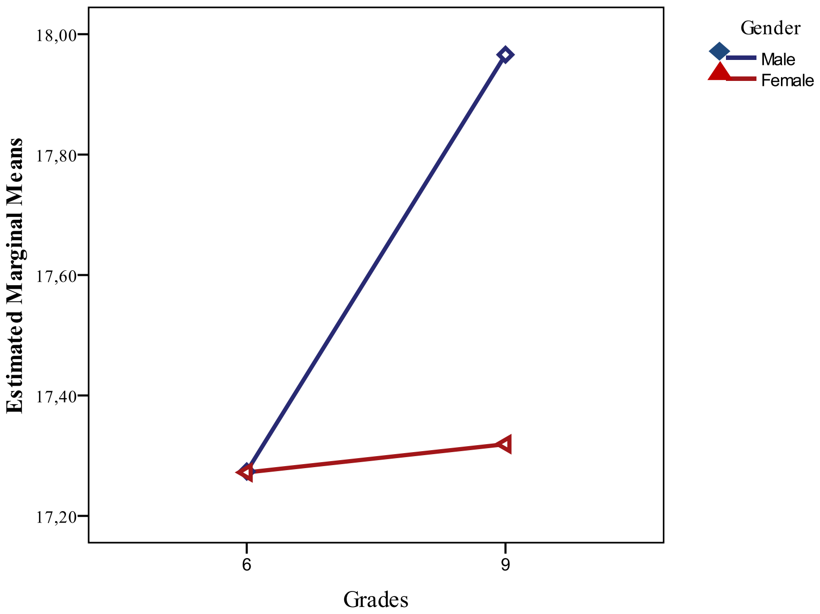

Figure 9.5(d). Gender and Grade interaction for MI_Not Annoy

The graph lines in figure 9.5(d) are demonstrating that the difference between boys and girls, which is very small in grade 6, is widened in grade 9. Moreover, increase in boys mean line is raised steeper from grade 6 to 9 than girls. While, girls' line is showing a horizontal pattern between the grades, which means that girls are showing the same feelings for mathematics as not annoying subject across the years. Though this effect is in the favour of boys but not found significant for α less 5%.

To this end these results where ensure that the variable "age" is a significant moderator for the model of mathematics attitude, there these results also indicate that, with growing age, students' attitude toward mathematics also strengthens. Hence, mathematics attitude alters both according to "age and "gender".

After this section, which addressed the general research question that "gender" and "age" are moderating variables, now the sample data is analysed for the next research question that addresses the effect of parents' socio economic status on the students mathematics belief, in the following part.

9.9 Influence of Parents' Education and Occupation on students' Maths Attitude

This section addresses the fourth main research question, which is in fact testing the hypothesis, in the theoretical model, that parents' socio-economic status has direct effect on the development of students' mathematics belief. This study has four independent variables as the representatives of parents' socio-economic status. Therefore, to avoid the manipulation of error occur in case of combining all variables all together for one scale, these are investigated separately each as independent variable to study their effect on the formation of students' mathematics belief. In addition, in the previous analyses results, it is found that under mathematics belief, the factor mathematics need belief is the only variable in which significant gender difference is found. Thus, for this part of the research, the analysis is delimited to study the effect of parents' education level and nature of occupation on the formation of sub-variable "mathematics need belief" with respect to her or his gender.

In the sample data, father and mother education is measured into four levels (scaling from 1 to 4, given on p.228). Therefore, with respect to these levels, students' belief is analysed for these level groups. Further, the next independent variable is nature of father's occupation or profession to observe its effect on the development of mathematics belief. As discovered from data that, in Sargodha, students from public schools mostly belong to low middle class. In currrent study, 57% of the sample data was collected from public schools where no tuition fees is charged from students, but nominal charges are taken as library or laboratory funds between 20 to 50 rupees[77]. In addition, the private schools participated in this study too, are of mediocre level regarding their fees package (As mentioned earlier in second section). On average, tuition fees of a student from private school (participated in the study) are between Rs. 1000 to Rs. 1500. Therefore, on the basis of the collected information, father's occupation variable is divided into five groups according to the nature of job and expected income level (from "1" to "5"). These were, "1" No job or father is died, "2" private business (low level of income) including labourer, "3" for private business (middle level) including shopkeepers, "4" for government employee, and "5" for teaching profession. Lastly, a question regarding mother's job was asked that is, does mother do job? Two options were provided: "1" for yes, and "2" for No. Only 14.2% (89 girls & 122 boys)

[77] As per the communication with head-teachers and students of participating schools.

of the students replied that their mothers do job (cf. Table 9.1). The ratio of these students is less than 1/5th of the total sample data, therefore, due to insufficient ratio within sample, this independent variable didn't include in the analysis.

9.9.1 Effect of Father's Education

A series of univariate analyses of variances are performed separately for each of the independent variable associated with parent's education and occupation, interacted with the exogenous variable gender for the dependent variable MB_Need. First, within group differences for the variable father's education level are discussed below.

Data are analysed for investigating the effect of the variable father's education on the development of mathematics need belief in students. Therefore, for the evaluation of the assumption of homogeneity of variances, Levene's test is observed and found satisfactory. Afterwards, the results for Univariate ANOVA for the groups regarding Father's education level for MB_Need were observed. A significant F-value confirmed that groups of students concerning four levels of father's education differ significantly [$F(3, 1443) = 5.425$, $p<.01$]. To investigate, more specifically, that which groups are significantly different for variable MB_Need, a Boneferoni Post Hoc test is run for all four groups (*illiterate* to *higher education level*). Three of the four groups are found significantly different: the groups of Illiterate *vs.* Higher education (means difference = 0.5524, $p < .05$), and primary *vs.* Higher education (means difference = 0.4109, $p < .05$) are significantly different. Positive signs of the means differences show that students from the families where fathers are having no education or primary education level are holding significantly more positive belief in mathematics as a source of getting scholarship, good job and necessary for self-recognition than the students from fathers of high education level.

After studying groups-differences for father's education variable regarding MB_Need, effect of father's education with respect to the gender of the student, are explored in the Table 9.13.

Interactions of IVs	*df*	*df* error	F	Levels	Gender	Mean	95% Confidence Interval Lower Bound	Upper Bound
F_Edu * Gender	4	1443	2.777*	Illiterate	Male	8.233	7.826	8.641
					Female	8.491	7.980	9.003
				Primary	Male	8.034	7.748	8.321
					Female	8.318	7.998	8.638
				High Sch	Male	7.876	7.688	8.065
					Female	8.164	7.961	8.367
				Higher Edu	Male	7.668	7.451	7.884
					Female	7.862	7.635	8.089
F_Ocup * Gender	5	1430	2.106	No Job/Died	Male	7.714	7.299	8.128
					Female	8.107	7.444	8.771
				Pvt. (Low)	Male	8.079	7.821	8.336
					Male	8.045	7.802	8.288
				Pvt. (Middle)	Male	7.858	7.665	8.051
					Female	8.114	7.911	8.317
				Govt. Job	Male	7.814	7.564	8.064
					Female	8.171	7.886	8.457
				Teaching	Male	8.113	7.547	8.678
					Female	8.350	7.219	9.481
M_Edu * Gender	4	1447	4.714**	Illiterate	Male	8.110	7.868	8.352
					Female	8.257	7.933	8.581
				Primary	Male	8.263	8.015	8.511
					Female	8.160	7.899	8.420
				High Sch	Male	7.646	7.426	7.867
					Female	8.031	7.807	8.255
				Higher Edu	Male	7.517	7.238	7.795
					Female	8.071	7.780	8.363

* $p < .05$; ** $p < .01$

Table 9.13. Effect of parents' variable on the students' mathematics *Need* belief

The interaction of father's education level and gender of the student is found significant [$F(7, 1435) = 3.301$, $p < .01$]. This shows that the father's education level affects the development of mathematics need belief differently in girls than in boys.

To study the pattern of differences for boys and girls, mean scores for variable MB_Need are plotted in Figure 9.6. Figure 9.6 clearly depicts that girls are showing better level of this belief as compare to boys in each group, especially for the groups having fathers of "no education" or "primary education", the gender difference is more widened for these groups than for the later two groups. However, the downward direction of both error bar lines with the increase in education level are confirming this fact that both boys' and girls' such belief for mathematics strengthens only when their fathers are not well educated.

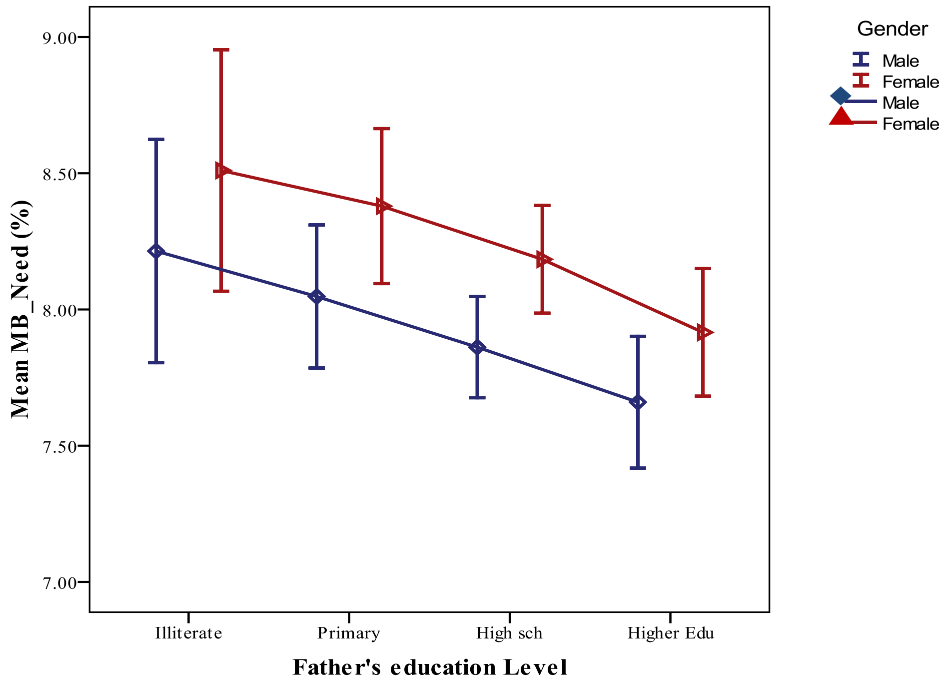

Figure 9.6(a). Effect of father's education and gender interaction on maths Need belief

To explore further this main effect of father's education on two age levels, means scores of attitudes for both boys and girls belonging to sixth and ninth grades are plotted in figure 9.6(b).

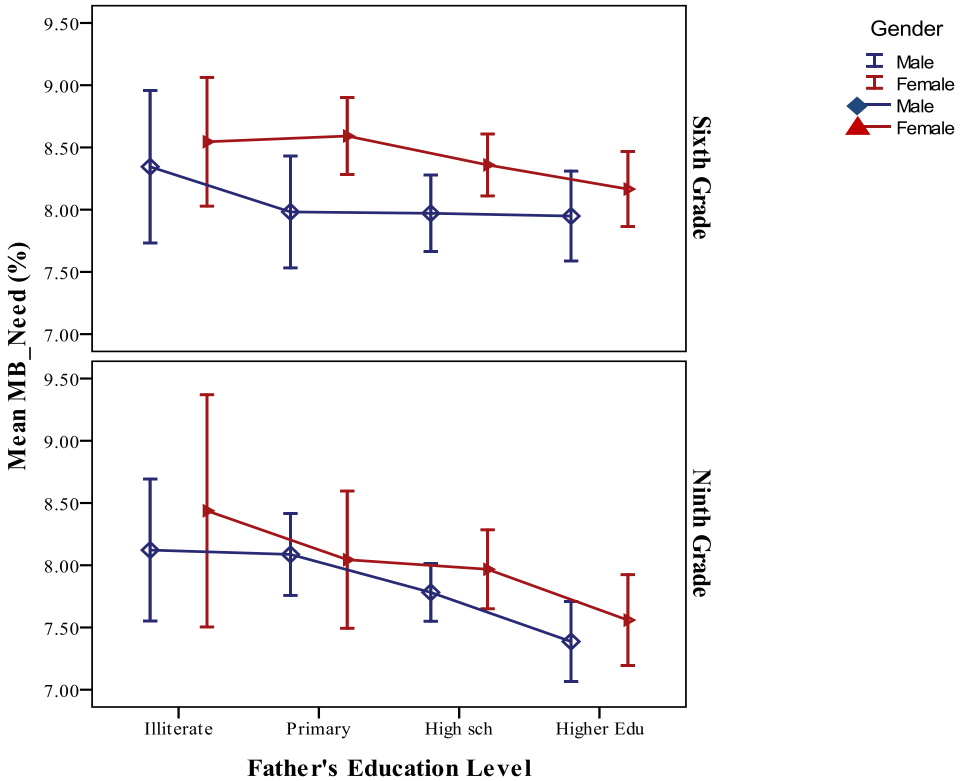

Figure 9.6(b). Effect of father's education and gender interaction at two grade levels

Girls at both grade levels, as shown in figure 9.6(b), are showing better level of need belief than boys, however, in grade nine both boys and girls are showing a decrease in their attitudes when father's education level has increased from primary to higher education.

From these results, it can be concluded that mathematics need belief is highly affected by father's education level. This aspect of mathematics attitude enhances only when student's father doesn't possess high level of formal education. Moreover, girls develop comparatively more belief of mathematics need than their counterpart boys. Other interesting fact that can be assumed is that, as students move in higher grades, this belief decline as shown in Figure 9.6(b). After observing the effect of father's education on the students' beliefs, now the effect of the nature of father's occupation in the development of students' mathematics belief is investigated below.

9.9.2 Influence of Father's Occupation

Father's occupation or expected income level is the next major independent variable for which the influence on the students' mathematics need belief is examined. Hypothesis for homogeneity of variances, for this variable, was also tested like the above one. Results from Levene's test is assured the equality of the variances among the groups [F (9, 1430) = .772, p = .642)]. At next step, Factorial ANOVA is performed to analyse the data for father's occupation to test the group differences of the students regarding their belief in mathematics ignoring their gender completely. Results demonstrate that groups of students, according to the nature of their father's occupation in the development of the mathematics need belief, are not significantly different [F (4, 1430) = .095, p = .984]. This non-significant F-value confirms that in the sample data of this research, father's occupation is not appeared as a significant factor in the development of students' belief in mathematics.

Later, to explore the effect of father's profession on the students' need belief with respect to their gender, in the same univariate analysis of variances, the interaction of father's occupation and gender for "Need belief" is run also. F-value, in Table 9.13, is found non-significant for this interaction [F (5, 1430) = 2.106, $p > .05$]. This depicts that the nature of the father's occupation does not affect boys and girls differently in the development of their mathematics need belief. To explore graphically, the level of boys' and girls' belief, mean scores are plotted against each category of profession in figure 9.7.

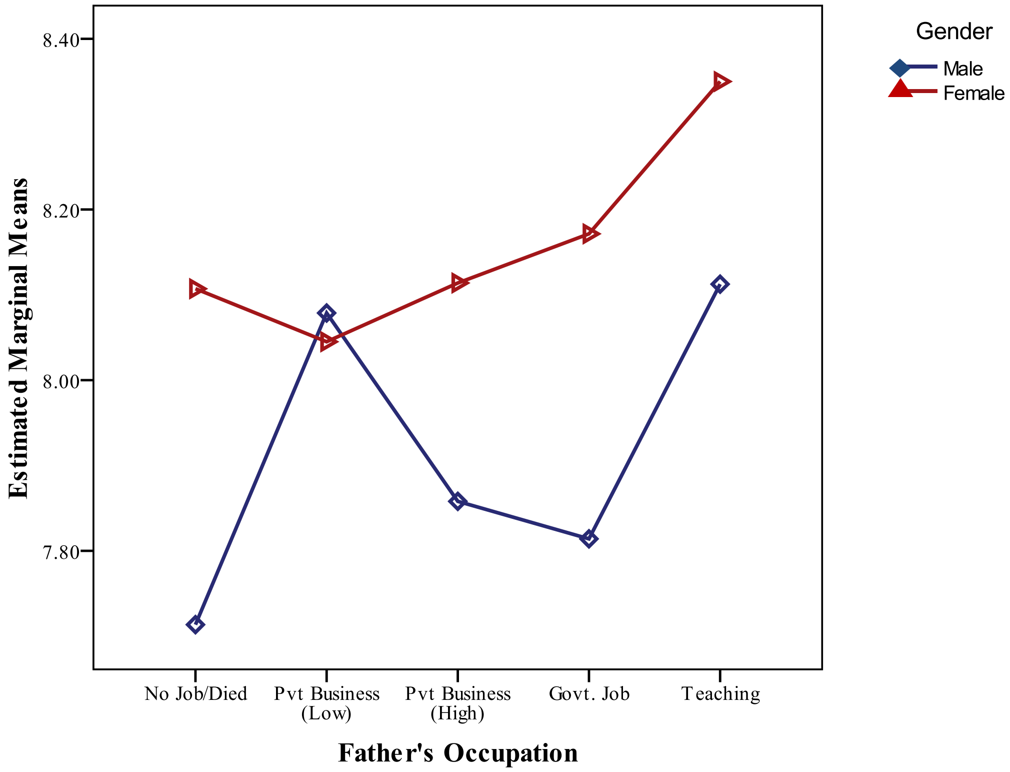

Figure 9.7. Effect of father's Occupation & gender interaction on Maths Need belief

The overall imapct of this graph is that, girls' need belief is either remained stable or in increasing mode with respect to their fathers' income level and profession, whereas, this situation is quite uncertain in case of boys. Therefore, it can be concluded that either in case of very poor financial situation or in little better financial conditions, boys decline in mathematics need belief. As it can be observed in Figure 9.7 that, when father is having low-income profession, only in that case, level of boys' belief overlapped with girls'. Though for teaching profession, a little raise can be observed in figure 9.6, but as mentioned earlier that only 46 students (9 girls & 37 boys) out of total sample, falls in this category therefore, due to very small proportion (3.1%), this increment is not appeared significant comparing with other categories. However, this is an obvious fact that parents' profession, if it is teaching, can play a motivating role in the development of positive attitude towards mathematics in students.

Now, next part is investigating the effect of the last independent variable under this category, that is, the effect of mother's education on students' mathematics belief.

9.9.3 Influence of Mother's Education

To explore whether students differ in their mathematics belief, if they are grouped according to their mother's education level, first the assumption of variance homogeneity is evaluated for mother's education. Results from Levene's test show that group variances are homogeneous for this variable too [$F (7, 1447) = 1.226$, $p = .285$].

For this variable too, univariate analysis of variances is run on the sample data for the variable MB_Need in two steps. At first, to analyse the groups differences, mother' education variable is added, and then to examine the effect of mother's education regarding gender, interaction of these variables are added in factorial ANOVA. The results for groups-differences regarding mother's education level confirm that, students, belonging to different groups, differ significantly in their mathematics belief [$F (3, 1447) = 4.757$, $p < .01$].

To determine those particular groups of students, which differ significantly, Bonferoni Post Hoc test is used and a set of two groups belonging to different level of mother's education are found significantly different. Those students whose mothers are having primary level of education hold significantly more positive attitude towards "mathematics need belief" than those who mentioned their mothers' education level till higher secondary school [Mean difference = $.36429^{*}$, $p< .05$]. To look it in a best way, means of need belief at each level of education are plotted in figure 9.8(a).

Figure 9.8(a) clearly demonstrates that when gender of the student is completely ignored, two main divisions appear which seem different, these are; mothers are having primary education, and the other is, mothers are having high school or higher education. The overall "mathematics need belief" of a student rises when mother either doesn't know read & write, or having nominal level of education (i.e., primary education), and it decreases in the case of highly educated mothers (high school & graduation level). Hence, it can be assumed from this significant effect that the student feels more strongly mathematics as the source of obtaining scholarship or to be praised, when their mothers are not having high level of education.

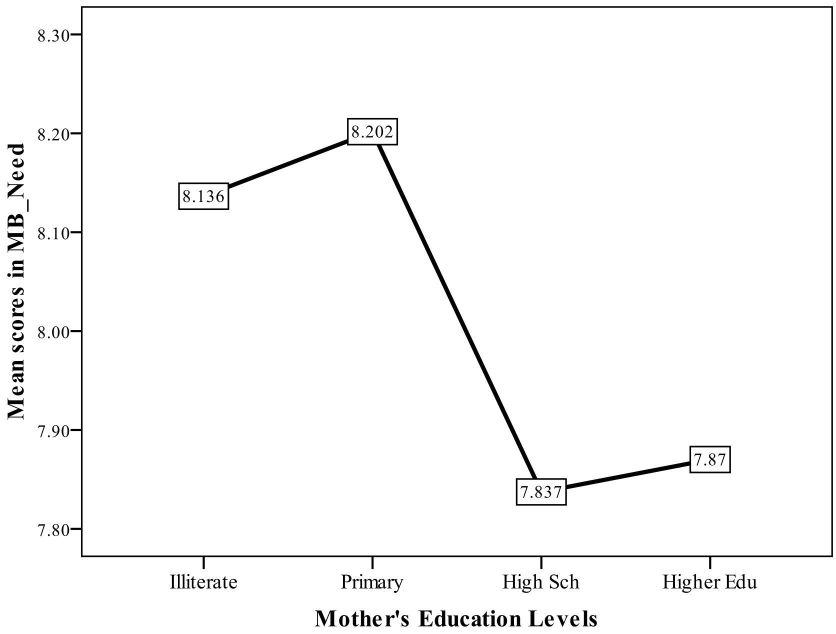

Figure 9.8(a). Mean scores in Maths Need belief regarding Mother's Education level

At the next step, interaction between the effect of mother's education and effect of gender is investigated for othe targeted dependent variable. The significant value of F indicates that level of mother's education influence differently on boy than on girl in the formation of mathematics need belief [F (4, 1447) = 4.714, p < .01]. To investigate further the direction of this influence on gender, mean attitudes of boys and girls are plotted on the graph in Figure 9.8(b).

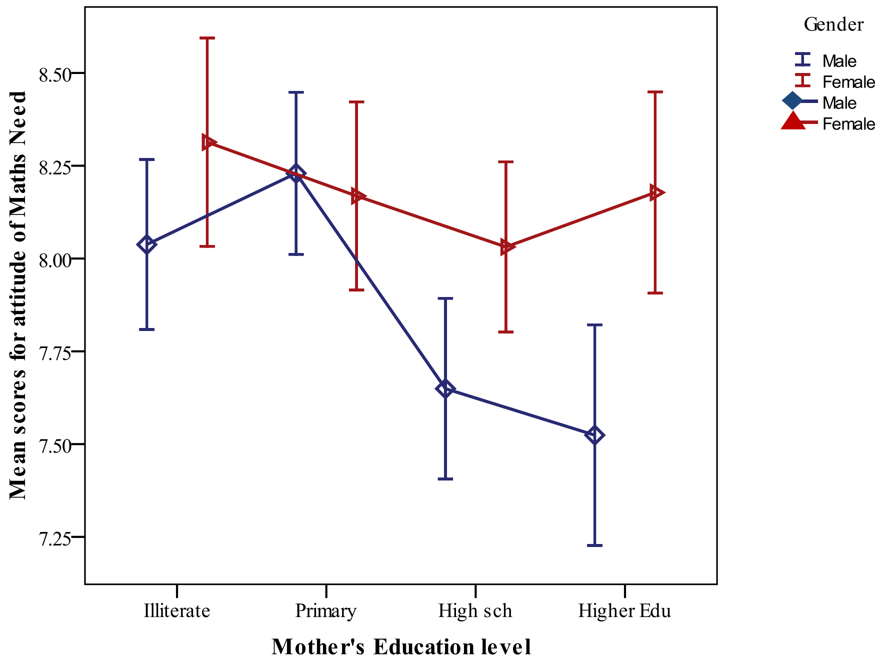

Figure 9.8(b). Gender Comparison for MB_Need Attitude with Mother's Education

Figure 9.8(b) presents relatively stable picture for girls across the four levels of mother's education except at high school where need belief showed little decrease, but this fall is non-significant. However, for boys, the mathematics belief is not stable and a rapid decline can be observed from primary level to high school continued to higher education of mother. Non-parallel lines, especially, after primary level, clearly indicates a significant interaction effect, which also affirms girls' superiority over boys. This interaction has more effect for low-level education of mother but as mother' education level is raised, this interaction is affected adversely only male students.

Though grade wise interaction is not found significant for the two previous independent variables, and thus excluded from the analysis discussion. But for the current independent variable, interaction of effect of mother's education level and effect of grade and age is found significant [$F (4, 1443) = 4.516$, $p < .01$]. To discuss this interaction effect in detail, means attitudes are plotted against both grades in Figure 9.8 (c) and 9.8(d).

The graph line, in Figure 9.8 (c), for sixth grade students shows little stable pattern across all the levels. However, ninth grade students showed a decline for high education level of mother, which demonstrates the same pattern like boys' when gender was included in this interaction.

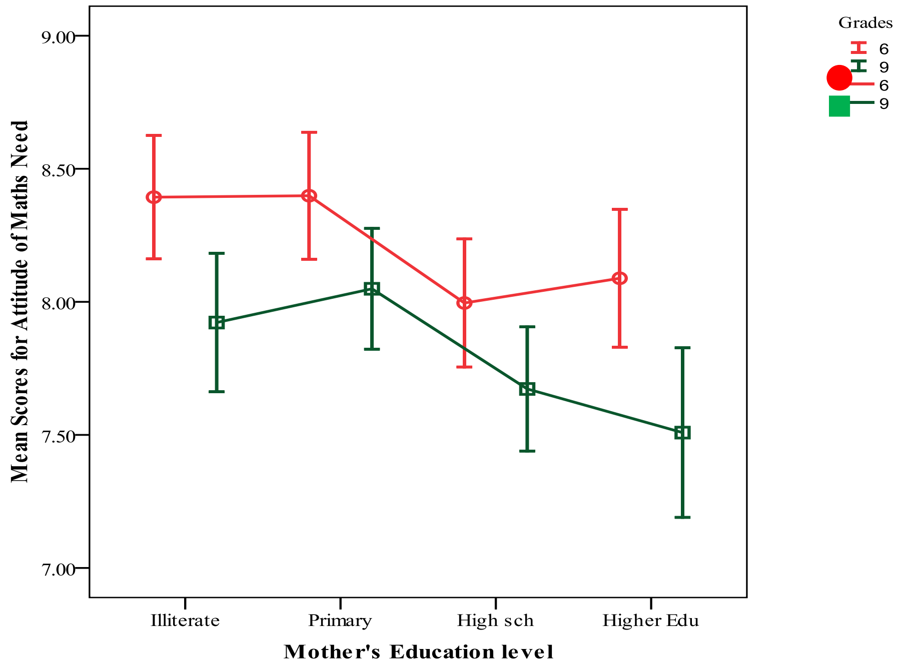

Figure 9.8(c). Grade comparison of MB_Need Attitude with Mother's Education

To observe this significant interaction effect in more depth, gender was also included in this interaction in Figure 9.8(d).

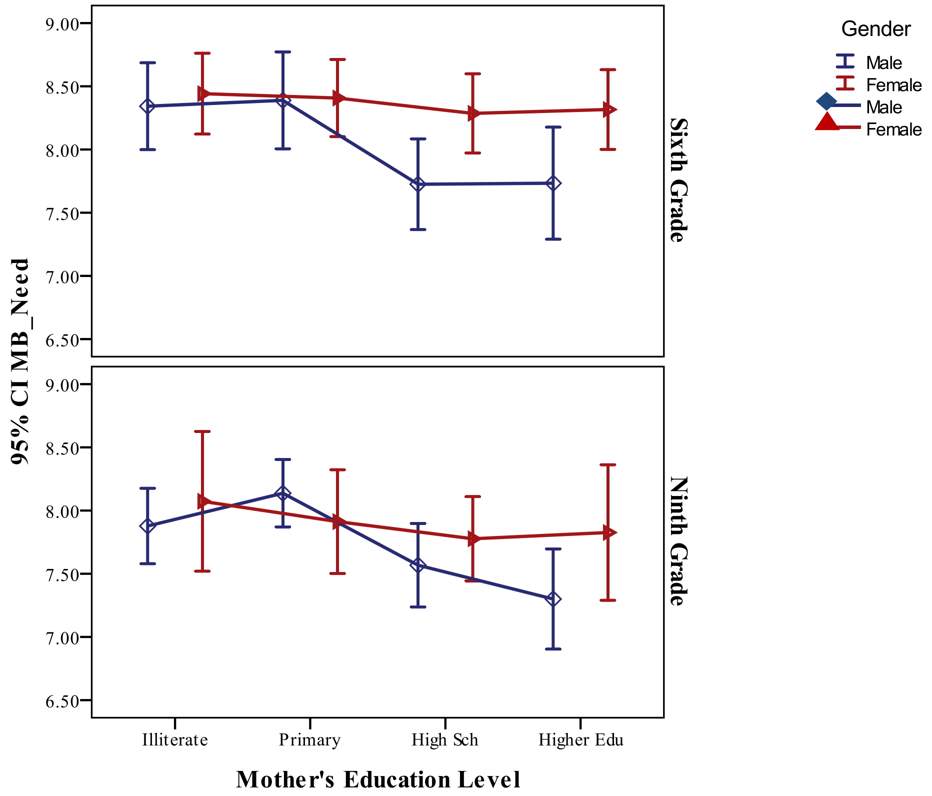

Figure 9.8(d). Effect of Mother's Education on Grade & Gender interaction for MB_Need Attitude

This pair of graphs, in figure 9.8(d), demonstrates that girls at both grade levels are depicting a fairly constant level of mathematics need belief across all four levels. On contrary, boys belonging to both age groups are demonstrating the same pattern of decline for high level of mother's education.

To this end, results of this research explored that both mother's and father's education level play a key role in the development of students' mathematics belief. The significant F-values in both cases demonstrate that parents' education has significant effect on the development of mathematics need belief. However, father's occupation is appeared non-significant variable at α= 5% level of significance, but if it will be raised to 10%, this variable, too, can be affective for this analysis because p value is found at 0.065. Regarding the effect of socio-economic status, in termas of parents' education and occupation, on mathematics belief for boys and girls, it is deduced that this effect is more influencing for girls than it is for boys, especially at higher levels. In case of father's education effect, although both boys and girls' belief is decreased as father education level is increased, this decrease is more pronounceed for boys. Whereas, in case of mother's education level, with the increase of mother's education level, boys feel less the need of mathematics for their fiancial and self recognition need. However for girls, mother's high education level put positive affect on the development of such belief of girls. Therefore, it can be concluded that, on contrary to boys, mother's higher education motivates girls more in the developent of their mathematics belief. Thus, in the response of the research question that, it is found that socio-economic status in terms of parents' education and occupation has a direct effect on the formation of mathematics belief in students, which is also hypothesized in the theoratical model. In addition, this is the low socio-economic status of the parents, which enhances the need belief of mathematics as the factor of mathematics attitude. Moreover, this enhancement is more pronouned for girls than boys. This is an obvious fact that disparities in one's life motivate her or him to search the way out and accelerate her or his struggle to overcome these disparities. Lastly, in the context of age and grade interaction, it is found in this research that parents' education influence more significantly the younger students' mathematics belief than the elder one's. Thus, it can be assumed that parents' socio-economic status affect mathematics attitude in early years of school education more, because children depend more on their parents, even in liking or decision making, they look towards their parents.

In this part of the analysis, the moderator variables were dealt, which cause the differences in mathematics attitude. Now in the next part of the analysis, in chapter 10, the causal relationships among the variables (extracted in our previous chapter of EFA) are explored, that is, how they contribute together in the formation of mathematics attitude. To investigate the causal effects of exogenous and mediating variables on the endogenous variables, theoretical model presented in chapter two (Figure 2.1) is taken as the base model.

Chapter.10 Path Analysis: Testing and estimation of the model

10.1 Introduction

On the base of literature review, several variables, relating to parents and teacher, were found which contribute significantly in the formation of students' mathematics attitudes. In the theoretical model, it was assumed that exogenous variables, parents and teachers through their help, expectation, behavior and encouragement affect mathematics attitude mediated by the endogenous variables of students' mathematics self beliefs. Moreover, teacher's factors, including; pedagogical skills, behavior etc., may cause direct effect on interest in mathematics. In addition, parents' education and the nature of profession also have the direct effect on the formation of mathematics belief. In previous chapter, in the response of first part of the research questions, students' differences are discussed with respect to gender, age, and parents' education and occupation by multivariate analysis. In this part of the analysis, this chapter is aimed, at first step, at generating the hypothetical causal model at different levels and degrees; a causal model that infers the relationships of sequential ordering in which change in one, causes the change in other variable. In next step, this hypothetical causal model is estimated with the help of the sample data collected for five scales, by using the path analysis under structural equation modeling. To achieve these goals, a well-defined statistical criterion was needed on the base of which this causal model is validated. Therefore, following is briefly explained the statistical criteria that is adopted in this part of the analyses.

10.2 Statistical criteria to test the model

In Path analysis under structural equation modeling, there are numerous criteria for assessing a structural model fit proposed by different statisticians (Byrne, 2010; Hancock & Mueller, 2006; Kline, 2011; Loehlin, 2004; Schumacker & Lomax, 2004). In depth theoretical explanation of these statistical measures is out of scope of this thesis thus presented a very brief interpretation of each measure, which is adopted for the present study.

There are basically four levels to reach at the testing of the model, these are; model specification, model identification, model estimation and model testing (Byrne, 2010; Hair et al., 2010; Loehlin, 2004; Schumacker & Lomax, 2004). The first requirement is *model* *specification*, which is, in fact, developing such theoretical model based on relevant theory and literature review that can be confirmed with variance-covariance data (Schumacker & Lomax, 2004; p.62). Thus, it involves the process of selecting variables of interest and proposing the relationship among them in a model. This step is already have achieved in the form of theoretical model earlier in chapter two in Figure 2.1, and hypothetical model is given later in this chapter. After this, the next stage is *model identification* on the basis of sample data, which is a primary requirement to precede statistically the model fit. A model is identified (*just-identified or overidentified*) if the number of data points is equal to, or greater than, the number of free parameters in a model. If the model is *underidentified* or not identified, that is, if the number of data points is less than the number of free parameters, then in such case, model fit stage can't be proceeded. In AMOS, only in the case of identified model, fit indices for a model can be obtained. Thus, all the models presented in this chapter are obviously identified one.

Manually the data points in a model can be calculated with this formula:

No. of data point = $\frac{m(m+1)}{2}$

where, "m" is the observed variables in a model.

Whereas, the number of "free parameters" in a model is the sum of all regression coefficients of paths in a model, variances, and covariance of independent variables present in model. Thus, for a model is identified, Number of Parameters > $\frac{m(m+1)}{2}$.

In structural equation modeling, *model estimation* means estimating all present parameters in a model. There are several estimation procedures elaborated by statisticians, among them, most commonly used in research are; *unweighted* or ordinary least square method (ULS or OLS), weighted-least squares estimation method (WLS), generalized least square method (GLS), Maximum likelihood method (ML). For the present analyses, ML-method is adopted to estimate the parameters of the hypothetical models because this method maximizes the likelihood of the observed sample (Kline, 2010). The distinguish characteristic of this method is that, it possesses desirable asymptotic properties, that is, it assumes multivariate normality of the observed variables (Schumacker & Lomax, 2010).

Although, it does not require a large sample like weighted least square method but even then, in the presence of a large sample, like the one present study have (N=1499), estimates can be expected asymptotically unbiased, consistent (probability of an estimator closes to population parameter increases) , and efficient (Kline, 2010; p.155).

The last and most important stage is *model testing*. The primary goal of using structural equation modeling is to explore a statistical significant model that has also *practical and substantive meaning* (Schumacker & Lomax, 2010, p.81). In general there are three main criteria to judge the significance and substantive meaning of the model, in which the first one is model testing. Model testing is the procedure to determine how well the data fit the model. This is the stage where it is tested that to what extent a theoretical model is supported and verified by the sample data. The basic statistic in model testing fit indices is Chi-square test. A statistically non-signifiicant χ^2-value affirms that model fit the data well. From this it means that the "sample covariance matrix and reproduced model-implied covariance matrix are same" (Schumacker & Lomax, 2010, p.81). But in the case of large sample size, e.g., N>700, χ^2 does not remain a consistent measure of model fitting (Hair, et al., 2009; Tabachnick & Fidell, 2007). Thus, it is highly recommended by researchers (Lomax, 1983; Schumacker & Lomax, 2010; Tabachnick & Fidell, 1996 & 2007) that, other fit indices should be used to measure the goodness of fit at the place of χ^2.

There are various measures along with χ^2-test that are highly recommended to take into account in order to test the model, these includes broadly; absolute measures or indices, incremental fit measures and parsimony measures. In the analysis of model fitting of present study, mostly adopted fit indices are followed as the model fit criterion presented in Table 10.1.

Model fit measure	Adopted Ranges	Interpretation
Absolute measures		
Chi-Square (χ^2)	Less than tabulated value	Less than table value of χ^2 at a given '*df*' decides the fitness of the model.
Normed Chi-square (CMIN/*df*)	1 to 5[78]	*Less than 1 is poor model fit while greater than 5 reflects a need for improvement*[79].
Root Mean square error of approximation (RMSEA)	below 0.06 (good) and less than 0.08 is acceptable[80].	It is population based index of fit and calculated as; RMSEA= $\sqrt{(\frac{d}{df})}$; where d = $\frac{\chi^2 - df}{N-1}$
Incremental fit measures		
Comparative fit index (CFI)	Greater than "0" and equal to "1"	Closer to 0.9 is good fit. A greater value of CFI indicates high average correlation between the variables.
Normed fit index (NFI)	Greater than "0" and equal to "1"	Closer to 1 is best fit, e.g; NFI = 0.9 proves a good model fit.
Parsimony measures		
Parsimony normed fit index (PNFI)	Greater than "0" and Closer to "1"	"0" means not fit; if "1" then model is good fit.

Table 10.1. Model fit measures and their acceptance ranges

The second criterion is to observe the significance of the path coefficients (at least for 5% level of significance). For the present research, the parameter estimates for paths significant at most for $p < .01$ are usually accepted. And the third criterion is to investigate the sign of the parameter estimate whether it makes any theoretical sense or not.

Last but not least, model fit (strictly statistically) is not the ultimate objective of the research because there may be the possibilities that even a misspecified model can fit the data. Therefore, among the plausible models that fit the data, it is highly important and recommended to observe especially in social sciences that model which fits the data well must be philosophically and theoretically meaningful. Further, such models can be possible in natural settings or exists in reality. As Kline (2010) remarked that, "success in SEM is determined by whether the analysis dealt with substantive theoretical issues regardless of whether a model is retained" (p.190).

[78] Schumacker & Lomax (2004) proposed the range till 5. Hair et al., (2009) suggested that in case of large sample size (>750), its acceptable ratio may increase.

[79] Schumaker & Lomax (2004) p.82.

[80] Loehlin (2004), p.69. Byrne (2001) mentioned RMSEA < 0.08 is acceptable.

Now before presenting the hypothetical model of this study to investigate the sample data to fit in this model, it is pertinent to explain few important key terms that are used in analysis afterwards.

Important Key terms for our Structural Models

In the analysis, for the sake of better explanation and to avoid the error during discussion, the models are defined on the base of the nature and level of endogenous and exogenous variables used in each model. The important point to clarify here is, that all the models are recursive models, which means, no construct is both a cause and an effect of other construct. Regarding the nature of the variables, at primary level, the model is named as "*Level One and degree one*" which contains total five variables**.** Thus, model 1 is based on two exogenous variables, parents and mathematics teacher, which are in fact the combined measure of their respective variables. Further, it has one mediating variable 'student' that is computed for its three respective variables. By degree one means, effect on mathematics attitude in terms of two endogenous variables mathematics belief and Interest in mathematics which measured mathematics attitude.

The next level of model is "*Level two and degree one*". At level two, six exogenous variables (three under parents' category and three under teacher's category) are taken into account. In addition, mediating factor "student" is represented by its three sub-variables. By "*degree one*" means, two endogenous variables as mentioned in above paragraph. Lastly, model "*level three and degree two*" means such structural model that demonstrates the causal effect of only one exogenous variable category (here, this stdy is limited to measure the teacher's effect at this level) on the nine endogenous variables; among them, three are mediating and six are endogenous variables measuring mathematics attitude in six dimensions.

Moreover, in the discussion and model drawing steps, just to avoid the repetition of variables' names, their codes are used instead, presented in Table 10.2.

Variables	Codes	Variables	Codes	Variables	Codes
Parents	P	Maths Teacher	T	Students Maths self beliefs	S
Parents Help	PH	Teacher Pedagogy	TP	Maths Self-concept	MSC
Parents Expectation	PE	Teacher Encouragement	TE	Maths Self efficacy	MSE
Parents Stereotypic beliefs	PS	Teacher Behavior	TB	Maths stereotypic belief	MST
Mathematics Belief	MB	Mathematics Interest	MI	Mathematics Attitude	MA
MB_G Utiltiy	MBU	MB_Intlect	MBI	MB_Need	MBN
MI_Enj	MIE	MI_Lik	MIL	MI_Not Annoy	MIA

Table 10.2. Variables (endogenous and exogenous) names and their codes

Now after presenting these important key terms, following is presented the estimation process of the theoretical model at primary level, that is, *Level one degree One* model.

10.3 Hypothetical Model 1 (at Level 1 and Degree 1)

In the previous chapters, five scales were developed and through EFA various factors were extracted to measure and determine the causal relationship between mathematics attitude and students' perception of their parents and teachers. To achieve this goal, sample data was collected in order to verify the theoretical causal model. The main objective of this part is to investigate the principle research question of interrelationship of variables that form mathematics attitude. Therefore, first the theoretical model is verified by converting it into hypothetical model of level one and degree one in Figure 10.1(a) by taking two exogenous and three endogenous variables. The general hypothesis is to test in this model is that, parents and mathematics teacher cause mathematics attitude directly and indirectly mediating through students' mathematics self-beliefs. This general hypothesis is divided into various hypotheses concerning each path between the variables given in figure 10.1(a).

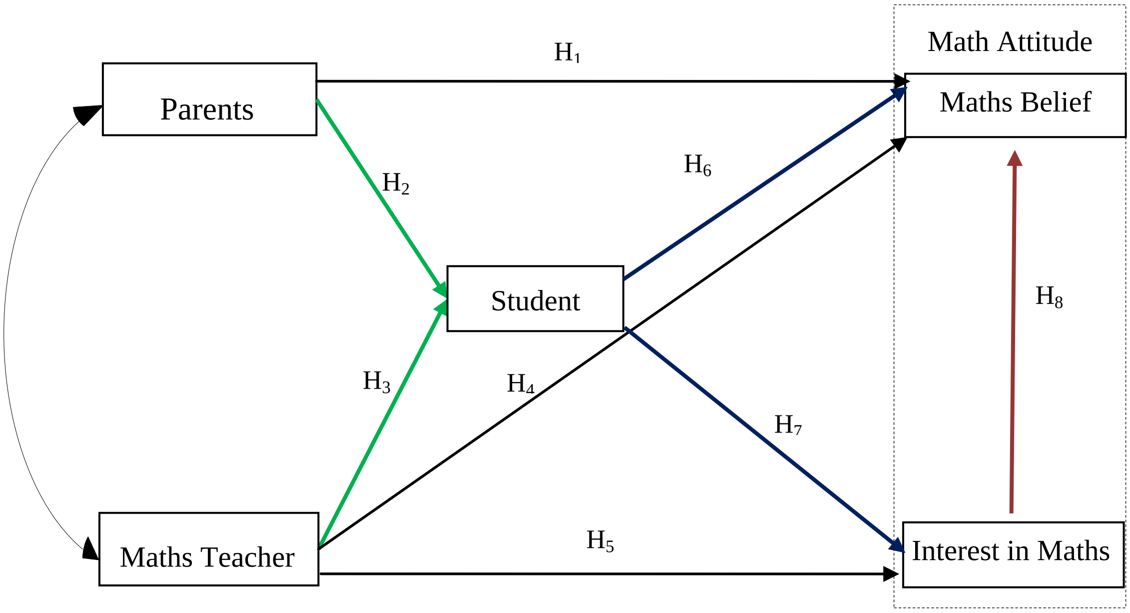

Figure 10.1(a). A hypothesized model (level 0 degree 1) of parents & teacher's effect on mathematics Attitude

In this hypothetical model we are intended to test the following hypotheses:

H_1: Parents cause direct effect on the students' mathematics belief.

H_2: Parents has direct effect on the mathematics self-beliefs of students.

H_3: Perception of teacher causes direct effect on students' mathematics self-beliefs.

H_4: Perception of mathematics teacher positively influences mathematics belief.

H_5: Teacher is positively related to the development of mathematics Interest.

H_6: Students self-beliefs are positively related to the mathematics belief.

H_7: Mathematics self-belief of student has positive effect on mathematics interest.

H_8: Mathematics interest causes mathematics belief more significantly.

Before moving ahead towards the estimation and testing of our model, the first step is to observe the interrelationship between the variables. Therefore, bivariate correlation coefficients are calculated of all five variables along with their means and standard deviations in Table 10.3.

Variables	N	Mean	S D	1	2	3	4	5
1. Parents	1388	28.464	3.658	1				
2. Math Teacher	1270	79.381	10.816	.310**	1			
3. Student	1362	39.940	5.168	.294**	.462**	1		
4. Math Interest	1352	36.207	6.501	.244**	.488**	.576**	1	
5. Math Belief	1395	30.452	4.576	.214**	.363**	.295**	.409**	1

** $p < 0.01$.

Table 10.3. Means, SD, and Correlations of Exogenous and Endogenous variables

The values for spearman's correlations are indicating significant correlations between the variables that seem neither very high nor very low. Being significant is obvious because by combining the factors in to one variable increase the combined effect too, due to which, significant correlation can be expected between the variables. The procedure of model testing by using ML method in path analysis is explained below.

10.4 Testing of General hypothetical model 1

As mentioned in primary hypothetical model 1, in figure 10.1(a), the basic objective is to determine the model, which can predict mathematics attitude under the influence of exogenous variables. Further objective is to estimate the direct and indirect effects of independent variables on endogenous variables, mathematics belief and mathematics interest, by testing the above-mentioned hypotheses. By taking parents and teacher as exogenous variables, student variable, her or his mathematics belief and mathematics interest as endogenous variables, path model under structural equation modelling is run in AMOS v.18 (in Figure 10.1b). Before proceeding further, it is pertinent to describe the meaning of the values shown in model. The values mentioned on the paths are the standardized regression coefficients of β. Moreover, the values mentioned on the rectangles are representing the total explained variances or R^2.

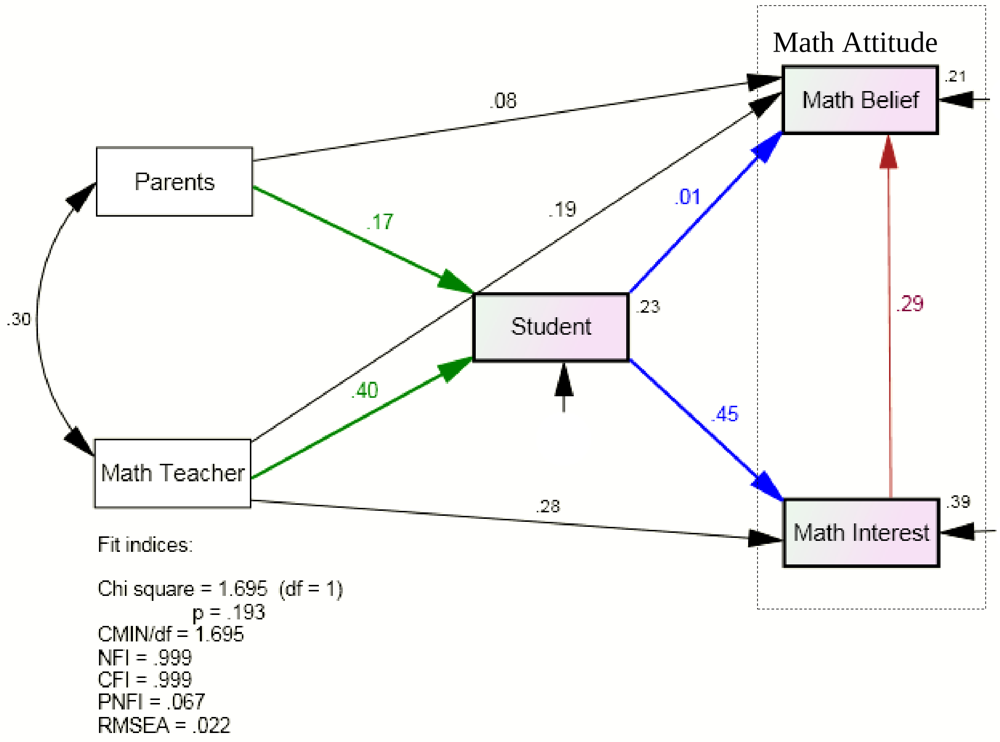

Figure 10.1 (b). The recursive path model of influence of parents & teacher's variables

All fit indices: $\chi^2_{\text{(normed)}}$ = 1.695, NFI = .999, CFI = .999, RMSEA = .022, & PNFI > 0, for this model are confirming that sample data fit the model best (to ameliorate our model the correlation between the exogenous variables is added, $Cor_{(P, T)}$ = .30). Hence, it is shown on the base of these results that the theoretical model (in Figure 2.1) exists at level 1 and for which, the sample data fit in model too. Now proceeding towards the hypotheses, which are shown in the form of their path estimates of variables in Table 10.4(a).

Parameter	Unstandradized	SE	t	Standardized
H_1: Parent → MB	0.106**	0.033	3.189	0.085
H_2: Parent → Student	0.242***	0.036	6.651	0.172
H_3: Teacher → Student	0.192***	0.013	15.357	0.401
H_4: Teacher → MB	0.079***	0.013	5.976	0.185
H_5: Teacher → MI	0.167***	0.015	10.913	0.278
H_6: Student → MB	0.013	0.029	.462	0.015
H_7: Student → MI	0.562***	0.031	18.013	0.447
H_8: MI → MB	0.205***	0.023	9.027	0.291

** $p < .01$; *** $p < .001$.

Table 10.4(a). ML estimate for path Model-1 of effect of parent and teacher on Maths Attitude

The path coefficients for H_2 and H_3 are affirming that exogenous variables (teacher & parents) have direct effect on student's mathematics self-beliefs [P→S = .17 & T→S = .40]. These exogenous variables are produced R^2 = .23 on the student variable (that is, 23% of total variance is explained by student variable). Further, for hypotheses, H4 and H5, teacher has also shown significant direct effect on mathematics belief and mathematics interest [T→MB =.19 & T→MI = .28]. Whereas, for parents' direct effect on mathematics belief in H1, for which the path estimate is 0.08, though significant at p = .001, is indicating that positive perception of parents causes positive and direct effect on the formation of mathematics belief. But this effect is comparatively less strong than teacher variable. Regarding the causal effect of S, our estimated model is depicting that student self-beliefs causing MI significantly thus confirming H_7 (b = .45). For these paths, direct, indirect and total effects are shown in Table 10.4(b).

Endogenous Variables	Causal Variables			
	Parents		Teacher	
	Unst.	St.	Unst.	St.
Student				
Direct Effect	0.242***	0.172	0.192***	0.401
Total Indirect	0.000	0.000	0.000	0.000
Total Effect	0.242***	0.172	0.192***	0.401
MI				
Direct Effect	0.000	0.000	0.167***	0.278
Total Indirect	0.136	0.077	0.108	0.179
Total Effect	0.136	0.077	0.275	0.457
MB				
Direct Effect	0.106**	0.085	0.079***	0.185
Total Indirect	0.031	0.025	0.059	0.0139
Total Effect	0.137	0.110	0.138	0.324

Note: Unst. is Unstandardized; St. is Standardized estimates. **p < .01; ***p < .001

Table 10.4(b). Effect of Exogenous on Endogenous variables for Model 1

Values in Table 10.4(b) are depicting that parents and teacher have significant indirect effect on mathematics interest mediated through student self-beliefs [0.08 & 0.179 respectively]. This fact is affirming that this model supports partial mediation, that is, "teacher" has significant direct as well as significant indirect effect mediated through "student" on MI. But this indirect effect of teacher did not confirm significant for mathematics belief (for H_6; b = .01, p> .05).

Concerning indirect effect of P on MI, presented in column 2 in table 10.4(b), one unit increase in parents' variable (P) caused a very low but positive effect (0.077) on MI. Whereas, P caused 0.11 increase in MB (0.085 directly and 0.025 indirectly). However teacher (T) which appeared a strong influential variable, with one unit increase in T's effect caused 0.457 unit increment in MI and 0.32 units in MB. Teacher also affected positively the students' self-beliefs; one unit T raised 0.401 units in S.

As our model supports partial mediation, therefore direct and indirect effect between the endogenous variables are presented in table 10.4(c).

Endogenous Variables	Causal Variables			
	Student		MI	
	Unst.	St.	Unst.	St.
MI				
Direct Effect	0.562***	0.447	----	----
Total Indirect	----	----	----	----
Total Effect	0.562***	0.447	----	----
MB				
Direct Effect	0.013	0.015	0.205***	0.291
Total Indirect	0.115	0.130	----	----
Total Effect	0.128	0.145	0.205***	0.291

Note: Unst. is Unstandardized; St. is Standardized estimates.
***p < .001

Table 10.4(c). Effects (Direct & Indirect) of Endogenous on other Endogenous variables for Model 1.

Presented in column 1 and 2 of table 10.4(c) are the direct and indirect effect of mediator "S" on MI & MB. Path estimates showed that S has strong effect in developing MI rather than MB. One unit in S caused 0.45 units in MI while on MB its effect is 0.145 units. However, mathematics interest (MI) is influencing significantly mathematics belief (MB) [MI→MB= .29]. Thus, MB in the causal model-1 is regressed by indirect influence of the exogenous variables through MI. The amount of explained variance by these variables is 39% ($R^2 = .39$) for MI and for MB it is amount to 21% ($R^2 = .21$). Concluding from these results, this model ensured the theoretical assumption that enhanced mathematics self-beliefs cause positively the mathematics attitudes of students towards mathematics.

Now by eliminating the paths for which variables do not have significant direct or indirect effect, model is rerun. This trimmed model is presented in figure 10.1(c).

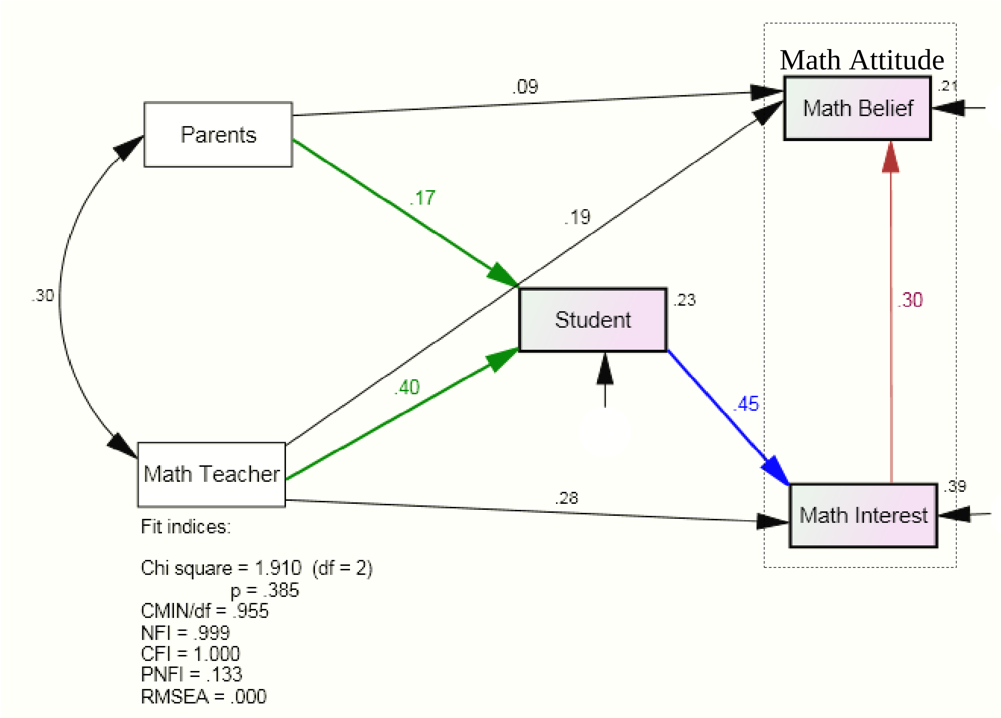

Figure 10.1(c). The trimmed causal model 1 of parents & teacher's effect

This trimmed model in figure 1.5(b) shows that with non-significant $\chi^2_{(2)}$ = 1.91, (p=.385) that, it also fits the data well. The comparative indices indicate that this model is found to have a best fit with $\chi^2_{(normed)}$ = 0.995, NFI = .999 & PNFI > 0. The relative fit of the model is 100% improvement that of independence model fit (CFI = 1.000). Further, the value of RMSEA is 0.00 within (.00 -- .05) range for 90% of the confidence interval at p = .948, which means that the hypothesis of good fit is accepted. The hypotheses are shown in the form of their path estimates of variables in Table 10.5(a).

Parameter	Unstandradized	SE	t-value	Standardized
H_1: Parent → MB	0.108**	0.033	3.314	0.087
H_2: Parent → Student	0.242***	0.036	6.654	0.172
H_3: Teacher → Student	0.192***	0.013	15.357	0.401
H_4: Teacher → MB	0.08***	0.013	6.219	0.188
H_5: Teacher → MI	0.167***	0.015	10.913	0.277
H_7: Student → MI	0.562***	0.031	18.027	0.447
H_8: MI → MB	0.210***	0.02	10.397	0.298
P correlated T	11.92	1.151	10.358	0.30

** p < .01; *** p < .001.

Table 10.5(a). ML estimates for trimmed causal model 1 of parents and teacher effect on Maths Attitude

The path estimates for the hypotheses in Figure 10.1(c) demonstrate that T→MB remained at 0.19 even after eliminating the path S→MB but the path P→MB rose to 0.09 ($p < .001$) in the trimmed model-1 in Fig. 10.1(c). Overall in this model, teacher variable is found strong exogenous variable, which has significant direct and indirect effect in the formation of attitude towards learning mathematics (as the total effects can be observed in the Table 10.14). However, parents directly affect student's mathematics self-beliefs, which later influence their mathematics interest. This model is also affirming that students' mathematics self-beliefs, in fact, develop their attitude in the form of interest in mathematics more significantly that becomes the source of mathematics belief later. As it can be observed that, by removing the path S→MB, regression coefficient of MI to MB is raised to 0.30. (Detailed direct and indirect effects; unstandardized and standardized, are given in Appendix 3A).

Now just to verify further to have best model, the path P→MB is deleted from model in Figure 10.1(c) and found $\chi^2 = 12.90$, df = 3 and $p = .005$. By using Chi-square difference test, $\chi^2_{(diff)} = 10.99$ is obtained with df = 1, which is found to be significant at $p < .001$ and thus equal-fit is rejected. This indicates that the model in Figure 10.1(c) is better model.

At the threshold of this discussion, parents and teachers, both are found to have influence directly and positively the students' self beliefs, which in turn cause their attitudes towards mathematics. It is also verified that positive perception of parents directly causes mathematics belief, while, teacher is found such a strong predictor that influence positively both constructs of mathematics attitude of the students.

Now after this initial stage of testing the model 1 of level one & degree one, the sample data for the model 2 of level two & degree one, is verified in the next part.

10.5 Detailed General hypothetical model

In the result of EFA on pilot data, six exogenous variables were found, three in terms of parents' variables and three for teacher factor. Whereas, there were total nine endogenous variables; three mediating endogenous variables related to student and six variables in mathematics attitudes (previously mentioned in Table 10.1). Figure 10.2 presents the specification of exogenous and endogenous variables in the detailed hypothesized model (at Level Two and Degree Two) with all fifteen variables[81].

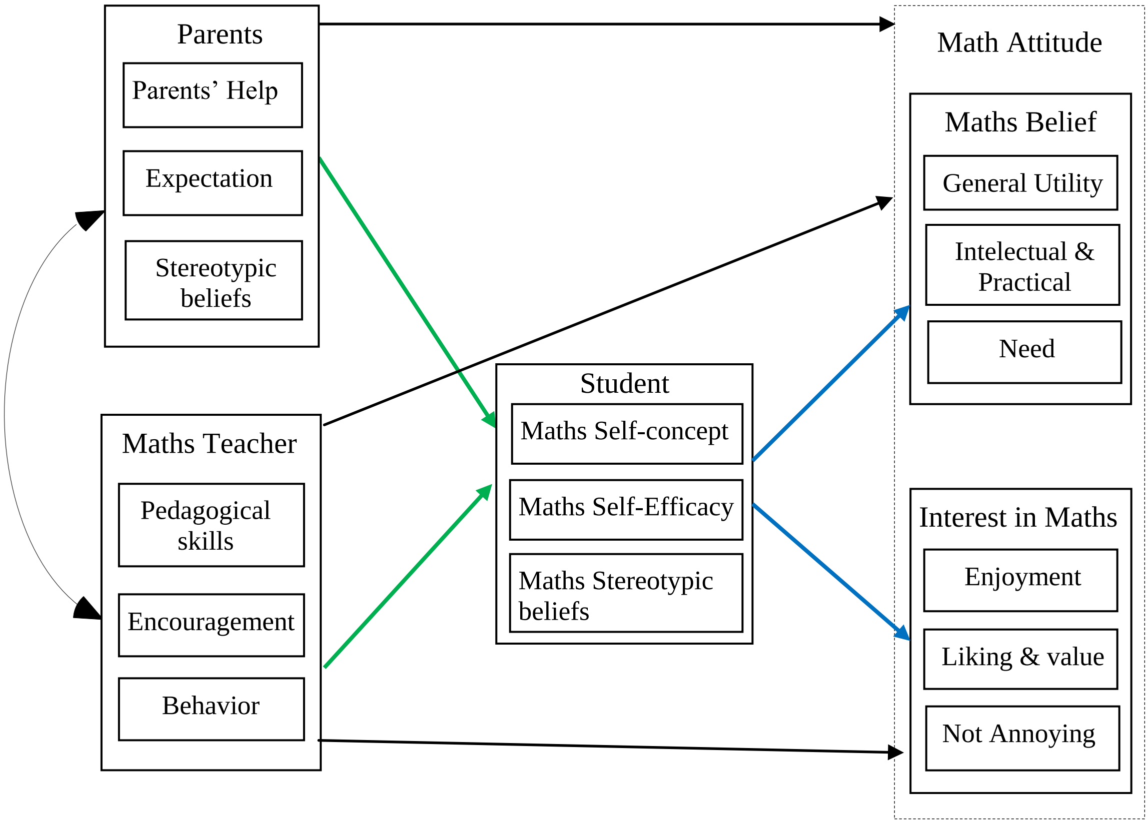

Figure 10.2. A hypothesized path model of parents and teacher's variables

In the first column, two exogenous variables are shown. Under parents' category, students' perception of their parents' help (PH), expectation (PE) and stereotypic beliefs (PS), and under teacher's category, student's perception of teacher's pedagogical skills to teach mathematics (TP), encouragement (TE), and student's perception of mathematics teacher's behavior in the class (TB) are presented. In the second column, mediating variables are shown, these are, students' own mathematics self-concept (MSC), mathematics self-efficacy (MSE), and mathematics stereotypic belief (MST). And in the last column of this hypothesized model, endogenous variable, mathematics attitude, in terms of its two constructs is placed. Mathematics belief is represented by further three sub-variables; student's perception of general utility of mathematics (MBU), intellectual & practical utility belief (MBI) and mathematics need belief (MBN). Whereas, interest in mathematics, this

[81] Here for the sake of better clarification we mentioned variables' names in the model but while testing e will use only the abbreviations of the variables mentioned in Table 10.1.

factor is having three variables, student's perception of enjoyment in doing mathematics (MIE), Liking & value (MIL), and mathematics is not annoying (MIA). Regarding the paths between the variables, for the convenience, these are drawn in different colours. Black coloured double arrow ray attaching exogenous variables is representing covariance between the variables, which also depicts the interrelationship among parents and teacher. Direct effect of exogenous variables on the mediator is represented by green coloured arrow head lines for which, parameter estimates will be shown in green colour too. Next the direct effect of exogenous variables on the endogenous variables is represented with black arrow lines. Whereas, indirect effect of exogenous or direct effect of mediator on endogenous variables, are shown with blue colour path arrows (path estimates will also be in the same colour). Finally, the causal effect among the endogenous variables is represented by brown colour arrows.

The general detailed hypothesized model in Figure 10.10 is examining that, exogenous variables in column one has a causal relationship with variables in third column directly and mediated through second column's variables. This hypothesis is dealt at two levels; that is, Model at Level 2 & degree 1, and Level 3 & degree 2 (explained above). Here it is important to mention that parents' education and occupation is treated as moderators along with the gender of the student in testing causal relationships among the variables in these models.

10.6 Testing of General hypothetical model 2 (level two and degree one)

In model 1, best-fit model is found with five variables, in which the variable parent is found to influence directly students' self-beliefs and mathematics belief. Therefore, more specifically by keeping the research question of parents' influence in view, following hypotheses are assumed for the hypothetical model 2:

H 1. Parents' help has direct influence on student's mathematics self-efficacy.

H 2. Student's perception of parents' expectation causes mathematics self-concept.

H 3. Student's perception of parents' stereotypic thought directly transmits to student and cause stereotypic beliefs in her or him.

Regarding parents' direct effect on mathematics belief,

H 4. Parents' help and expectation may directly influence mathematics belief.

On the parallel side regarding mathematics teacher,

H 5. Mathematics teacher's pedagogical skills develop student's mathematics self-concepts.

H 6. Student's perception of teacher encouragement has positive relation with mathematics self-concept.

H 7. Teacher's better pedagogy causes mathematics belief.

H 8. Student's perception of teacher's pedagogical skills has a direct causal relation with "interest in mathematics" construct.

H 9. Teacher's encouragement influence directly student's mathematics self-efficacy.

H 10. Student's perception of teacher's behavior creates a causal effect on student's mathematics self-concept.

H 11. Teacher's encouragement direct causes mathematics interest.

And concerning the causal effect within endogenous variables, following are the hypotheses:

H 12. Mathematics self-concept accelerates student's mathematics self-efficacy.

H 13. Better Mathematics self-concept of a student enhances mathematics interest.

H 14. Self-efficacy in mathematics causes mathematics interest.

H 15. Mathematics belief can be caused positively by enhanced mathematics self efficacy.

H 16. Mathematics interest predicts positively mathematics belief within mathematics attitude.

As parents and teacher are the strong social factors and in an educational process their interaction has significant effect on student. Therefore, regarding their relationship it can be hypothesized that parents and teacher correlate positively in the model 2 in figure 10.2.

To draw the possible path links between the variables in order to explore the relationships among them, bivariate correlations among them are computed along with their means and standard deviations in Table 10.6.

	N	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1.Maths Belief	1395	30.452	4.576	1										
2.Maths Interest	1352	36.207	6.500	.409**	1									
3.Math Self-Concept	1430	18.586	3.997	.268**	.626**	1								
4.Math Self-Efficacy	1455	12.762	1.833	.288**	.331**	.260**	1							
5.Student Stereotypic belief	1455	8.538	2.370	-.039	-.044	-.088**	-.046	1						
6.Parents Help	1455	12.052	2.362	.184**	.200**	.176**	.235**	-.053*	1					
7.Parents Expectation	1448	10.260	2.568	.165**	.280**	.366**	.109**	-.105**	.055*	1				
8.Parents Stereotypic belief	1472	6.112	1.678	-.051	-.166**	-.192**	-.018	.194**	-.019	-.244**	1			
9.Teacher Pedagogy	1416	24.667	4.069	.335**	.416**	.408**	.267**	-.103**	.231**	.273**	-.217**	1		
10.Teacher Encouragement	1399	36.096	5.131	.352**	.471**	.448**	.328**	-.019	.324**	.241**	-.135**	.617**	1	
11.Teacher Behavior	1402	18.422	3.862	.210**	.316**	.368**	.154**	-.109**	.159**	.214**	-.118**	.478**	.480**	1

* $p < 0.05$; ** $p < 0.01$

Table 10.6. Means, SD, and Correlations among the Eleven Endogenous and Exogenous variables

Different numbers of students against each variable are showing that, out of 1499 students, there are respondents who either didn't respond for respective variables or were the outliers. Thus analysis used complete cases only.

In the light of the research hypotheses and correlations given in Table 10.6, tha causal paths among the exogenous and endogenous variables are drawn and run in AMOS by using maximum likelihood estimation. Total 30 models were estimated with different combinations of the paths in the light of the theory and hypotheses and modifications were made in the light of correlations among the variables. The one, with relatively better statistics, is presented in Figure 10.3. Absence of a path between the variables implies lack of hypothesized direct effect.

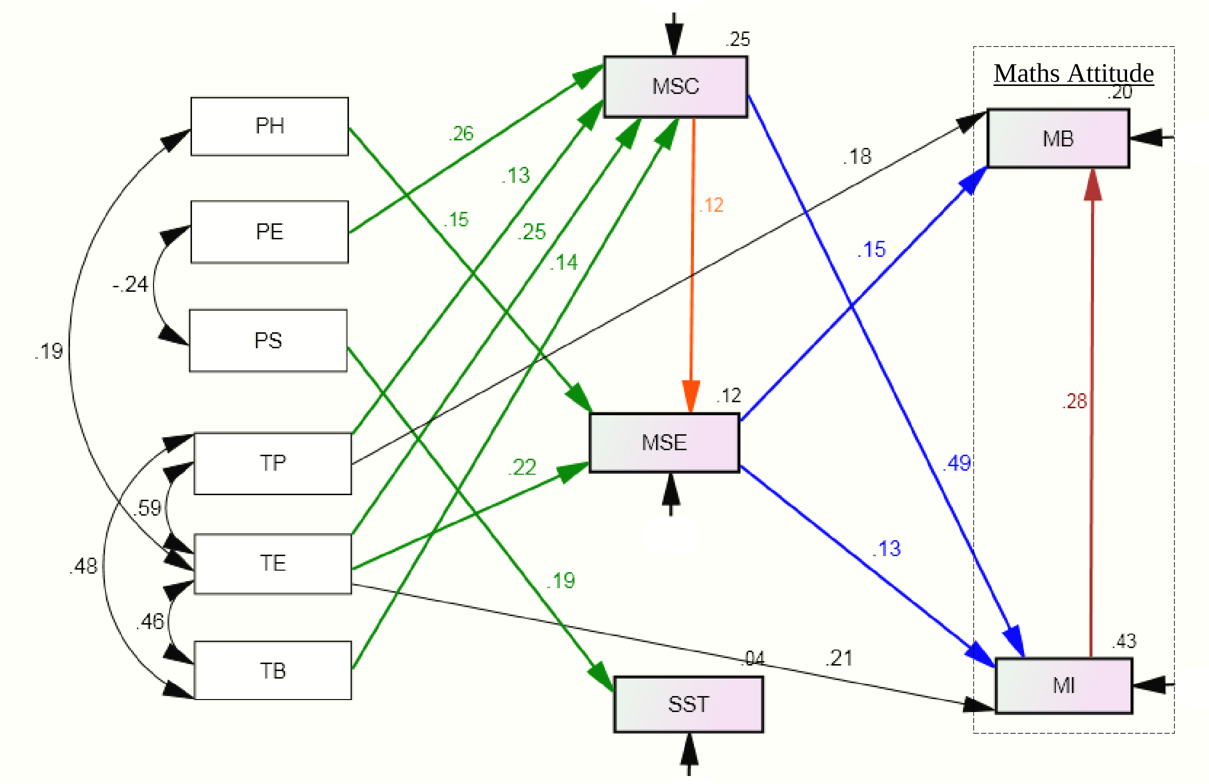

Figure 10.3. Model 2 (level 2 & degree 1) of mathematics attitude formation under the influence of parents and teacher's variables.

The absoloute fit index $\chi^2 = 339.763$ (df = 36), $p < .001$ is statistically significant, as mentioned earlier, that in case of large sample sizes this index do not remain consistent. Therefore, comparative and parsimonious indices are observed. The relative fit of the model (CFI = .921) shows 92% improvement that of independence model fit. Normed fit index (NFI = .903), PNFI = .493 and in addition the magnitude of residual, RMSEA = .075 are indicating that model in figure 10.3 is marginally acceptable model (Song et al., 2009; Tabachnick & Fidell, 2007). These results provide another evidence for the proposed theoretical model of developing mathematics attitudes under the influences of social factors (parents and teacher) at level two. Affirming the theorization of social influence on mathematics attitudes, variables, parents' help, expectation and stereotypic beliefs along with teacher's pedagogical skills, encouragement and behaviour, are found significant predictors for the attitudes of the students towards learning mathematics.

Regarding path estimates, all paths showed in the model 2 are statistically significant at $p < .001$. Those paths, whose estimates are not significant, are excluded from the model. Significant path estimates for our hypotheses are presented in Table 10.7.

Hypotheses				Unstandardized coef. (β)	S.E.	t-values	Standardized coef. (b)
H_1:	PH	→	MSE	.113***	.019	5.779	.147
H_2 :	PE	→	MSC	.386***	.035	11.093	.257
H_3 :	PS	→	SST	.273***	.037	7.455	.193
H_4 :	PH	→	MB	---	---	---	---
H_5 :	TP	→	MSC	.128***	.029	4.394	.135
H_6 :	TE	→	MSC	.189***	.023	8.090	.245
H_7 :	TP	→	MB	.202***	.029	7.015	.182
H_8 :	TP	→	MI	---	---	---	---
H_9 :	TE	→	MSE	.081***	.010	8.110	.225
H_{10} :	TB	→	MSC	.137***	.028	4.919	.137
H_{11}:	TE	→	MI	.266***	.030	8.889	.209
H_{12} :	MSC	→	MSE	.059***	.013	4.584	.125
H_{13} :	MSC	→	MI	.807***	.038	21.509	.491
H_{14}:	MSE	→	MI	.455***	.077	5.890	.130
H_{15}:	MSE	→	MB	.375***	.064	5.874	.150
H_{16} :	MI	→	MB	.199***	.019	10.339	.279

*** $p < .001$.

Table 10.7. Hypotheses of cause and effects for mathematics attitude model 2

Out of sixteen causal paths proposed in the hypotheses, fourteen confirmed the significant causal effect directly or indirectly on the development of MI and MB. However, for two hypotheses; H_4 and H_8, cause and effects are not established statistically significant. PH is not found a significant predictor of MB, whereas, TP is not found to have direct effect on the development of MI. Therefore, after removing these paths, the model is rerun for which direct and indirect effects of exogenous variables on endogenous variables presented in Table 10.8(a).

Endogenous Variables	Causal Variables											
	PH		PE		PS		TP		TE		TB	
	Unst	St.	Unst	St.	Unst	St.	Unst.	St	Unst.	St.	Unst.	St.
MSC												
Direct Effect	---	---	.386***	.257	---	---	.128***	.135	.189***	.245	.137***	.137
Total Indirect	---	---	---	---	---	---	---	---	---	---	---	---
Total Effect	---	---	.386	.257	---	---	.128	.135	.189	.245	.137	.137
MSE												
Direct Effect	.113***	.147	---	---	---	---	---	---	.081***	.225	---	---
Total Indirect	---	---	.023	.032	---	---	.007	.017	.011	.031	.008	.017
Total Effect	.113	.147	.023	.032	---	---	.007	.017	.093	.255	.008	.017
SST												
Direct Effect	---	---	---	---	.273***	.193	---	---	---	---	---	---
Total Indirect	---	---	---	---	---	---	---	---	---	---	---	---
Total Effect	---	---	---	---	.273	.193	---	---	---	---	---	---
MI												
Direct Effect	---	---	---	---	---	---	---	---	.266***	.209	---	---
Total Indirect	.051	.019	.322	.130	---	---	.107	.068	.195	.154	.114	.069
Total Effect	.051	.019	.322	.130	---	---	.107	.068	.460	.363	.114	.069
MB												
Direct Effect	---	---	---	---	---	---	.202***	.182	---	---	---	---
Total Indirect	.052	.027	.072	.041	---	---	.024	.022	.126	.140	.026	.022
Total Effect	.052	.027	.072	.041	---	---	.226	.203	.126	.140	.026	.022

Note: Unst. is Unstandardized; St. is Standardized estimates. ***p < .001

Table 10.8(a). Causal effects (direct, indirect and total) of exogenous variables on mathematics attitude

Parents' variable, whose total effect is found 0.242 on student and 0.08 on MB in model 1, here in model 2, when splitted to three variables, picture of causal effect is refined. No direct effect of any variable of parents is found on the MB, however, PH have direct effect on MSE (= 0.113). Whereas, one unit increase in PE causes 0.386 units positive effect on MSC and 0.023 on MSE. However, PS develops only SST, 0.273 units, which means, that parents' stereotypic beliefs are the main source for developing gender biased mathematics stereotypes in students.

Moreover, concerning indirect effect of parents in the development of mathematics attitude, PE is found to establish an indirect causal effect on MI and MB. Statistically speaking, 1 unit in PE raised 0.322 times MI indirectly, while developed 0.072 units of MB. Further, PH is also found to have indirect effect on both constructs of mathematics attitude; MI and Mb, but less stronger than PE. Detailed description of all effects is presented in Table 10.8(a).

Teacher, which appeared a strong predictor in model 1 (in figure 10.1 C), last three columns in Table 10.8 (a) are demonstrating an elaborative picture of this effect for model 2. Regarding direct effect, TP has affirmed strong effect on MSC than MSE. Whereas, TE is found comparatively more influencing variable that caused 0.245 units on MSC and 0.255 units on MSE. Third variable TB has also exerted a direct effect on MSC and MSE. Concerning direct and indirect effect on MI and MB, again TE is found to affect MI both directly and indirectly mediating through MSC and MSE (total effect of which was found 0.363). Whilst, TP has established causal relation, both directly and indirectly, with MB (for which, total effect is found 0.203). However, no direct causal effect is found for TB but an indirect effect is explored on both MB and MI (0.069 and 0.022 respectively).

To this end, after observing results regarding the effects of exogenous variable on endogenous variables, it can be concluded that parents' encouragement directly influence students' mathematics self-concept, while, with their help they enhance mathematics self-efficacy, which in turn develop mathematics attitude. While, teacher directly influences student's mathematics self-concept through her or his pedagogy, encouragement and positive behavior, which in turn develops interest in mathematics directly or mediated through student's mathematics self-concept. These exogenous variables are produced $R^2 = .25$ on MSC (that is, 25% of total variance is explained by student's mathematics self-concept) and on MSE it was amount to 12% (R^2 = .12). To explore that how mathematics self-concept and efficacy cause mathematics attitude, direct and indirect effects between these exogenous variables are computed in table 10.8(b).

Endogenous Variables	Endogenous Variables					
	MSC		MSE		MI	
	Unst.	St.	Unst.	St.	Unst.	St.
MI						
Direct Effect	.807***	.491	.455***	.130	---	---
Total Indirect	.027	.016	---	---	---	---
Total Effect	.834	.507	.455	.130	---	---
MB						
Direct Effect	---	---	.375***	.150	.199***	.279
Total Indirect	.188	.160	.090	.036	---	---
Total Effect	.188	.160	.465	.187	.199	.279

***** p < .001.**

Table 10.8(b). Effect (direct & indirect) of Endogenous on other Endogenous variables

Among mediators, cause and effect relationship between MSC and MI is found most strong relationship. With the increase in unit of MSC, MI is accelerated to .49 units, whereas, MSE has caused 0.13 units in MI. This variable MI further predicts MB within the premises of mathematics attitude. Whereas, MSE also causes direct effect on MB but for MSC, no direct relationship is established on MB. Concerning amount of variance explained by these variables, MSC and MSE together with TE are produced 43% on MI (R^2 = .43), while, MB has explained 20% of variance (R^2 = .20). This shows that the causal effect of exogenous variables that transmit to the mathematics self-concept converts into a causal effect on the development of mathematics interest as the factor of mathematics attitude. This mathematics interest later predicts significantly mathematics belief.

Next, in order to improve this model (as normed χ^2 was large), first causal path of PS to SST is removed and rerun the model. Normed χ^2 is not decreased significantly with this modification; therefore to ameliorate it further, some more changes are introduced in the form of exogenous variables related to parents' socio economic status in this model. Detailed procedure and results are given below.

10.7 Trimmed Model- 2

The vigilant thing in the model-2 was the dependent variable SST, which didn't develop any causal relation with other endogenous variables. But significant direct effect of PS→SST is indicating that this variable may have some moderating characteristics. Because SST variable is measured by the scale "males are best in mathematics" which indicates gender biased responses, that may raise the possibility of moderation in the data regarding gender of the student. Thus, for the sake of having better model, first the model is tried by removing SST. Results are not very much improved than the previous ones [$\chi^2_{(normed)} = 7.14$; NFI = .912; CFI = .923, & RMSEA = .061]. By observing the correlations among the variables in Table 10.6, another path TB→SST is added, and model is rerun with these modifications. Results of fit indices are improved especially normed chi-square decreased, while other comparative and parsimonious indices are also closer to best fit. To refine this model further, the additional correlations of other exogenous variables is added in the light of bivariate correlations in Table 10.6.

In the previous chapter, from the results of multivariate analyses, significant differences were found in mathematics belief on the bases of father and mother's education. Thus, in order to improve the model 2 and to study the effect of these moderating variables, model modifications are performed on the basis of theoretical relevance. First, father and mother education variables are introduced, with these modifications fit indices of the model are improved. Later, another variable of father occupation is added in the model, with this modification the fit indices improved further. Therefore, three variables as the indicators of the socio-economic status of the parents; father and mother's education level education and father occupation, are added in Figure 10.3. With these modifications the model is rerun in Figure 10.4.

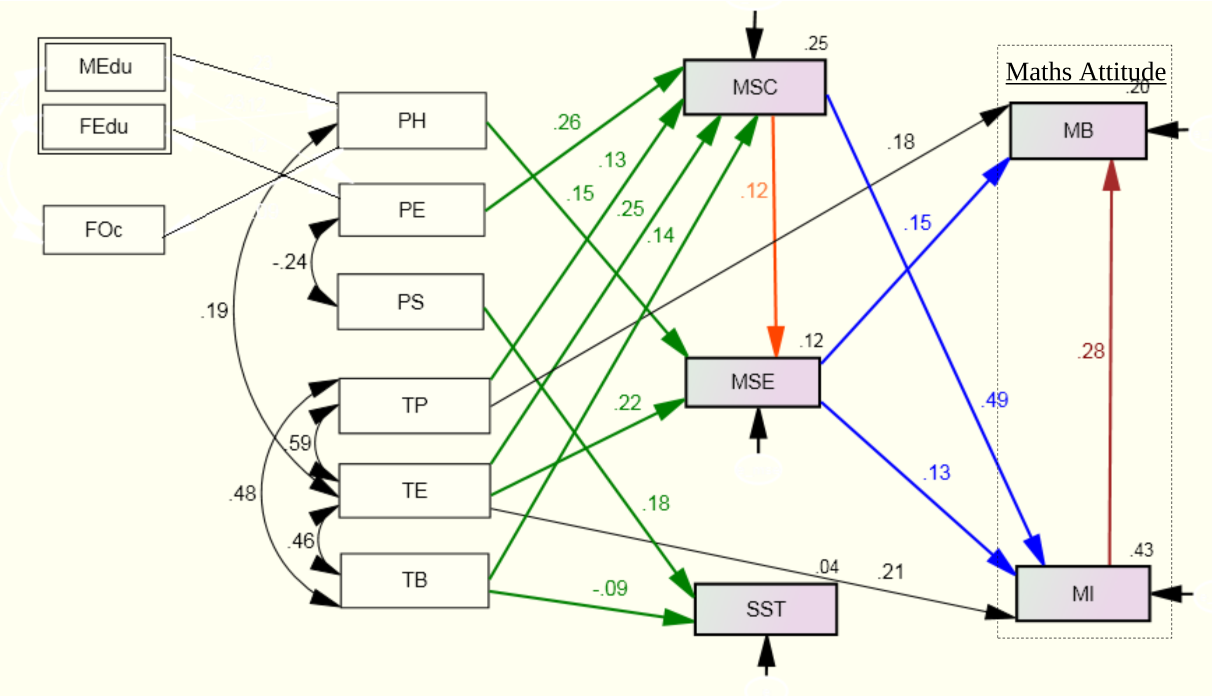

Figure 10.4. Trimmed Model 2 of parents and teacher's causal effect

The absolute index for the trimmed model-2 in figure 10.4, $\chi^2 = 386.315$ (df = 63), $p < .01$; is significant but normed χ^2 decreased to 6.14 which is marginally acceptable. Therefore, proceeding towards the comparative and parsimonious indices, these indices are found, NFI = .907, CFI = .919 and PNFI = .544. These values are indicating that relative fit of the model is 92% improvement that of the independence model fit while parsimony index is also in acceptable range. Moreover, residual mean square error, RMSEA = .058 is also decreased and is within the range. These statistics are showing improvement in the model as compare to the previous fit in figure 10.3 and therefore demonstrating this final model 2 in figure 10.4 fits the data well. In this model, in Figure 10.4, the additional path TB→SST, for which the path estimate (= -.09) is found significant ($p < .01$). Negative sign of the path estimate is confirming the theoretical assumption, that is, positive behaviour of the mathematics teacher reduces stereotypic beliefs in students. While, no other change regarding path estimates of causal relationships in the trimmed model 2 is found except the causal path estimate of PS→SST is decreased to .18 from .19 after introducing new path TB→SST. However to improve our model fit statistics, correlations between the errors are added in the model (Berg et al., 2010). Detailed indirect, direct and total causal effects of all exogenous variables and mediators on endogenous variable are provided in Appendix 3B.

The major moderating variable that is found in the previous chapter during analyses of variances for mathematics attitude was gender. In the model of formation of mathematics attitude, the causal communication between the exogenous variables and mediators may have different effect on mathematics attitudes according to the gender of the student. As the one that is observed in figure 10.4, that SST, which measured gender biased beliefs in maths, has developed a positive relationship with PS, while TB→SST is appeared negative. Therefore, these reflections lead us to explore this causal effect for boys and girls separately in the model. In addition, to observe the effect of gender on the direct and indirect effects of the exogenous variables on remaining endogenous variables, multi sample technique is adopted for analysis, explained in following part.

10.8 Testing of General hypothetical model 2 for gender

At this stage of analysis, final model is analysed, which was obtained with most plausible fit in Figure 10.4 , now for moderator gender. The sample data of 1499 students for this study were obtained from 678 girls and 821 boys, therefore to proceed this analysis, either we can continue with the same sample set with introducing two groups and can adopt multi group analysis or we can divide the whole sample data into two samples of boys and girls and can proceed with multi sample technique in AMOS. As this research is dealing with structural model not measurement model, therefore, both methods have same value for this part of analysis. A multi sample technique is adopted to continue the process and data is divided into two samples; sample of boys and sample of girls. Three main objectives are dealt of in this section; first is to verify that the causal model equally exists and statistically feasible for boys as well as for girls. Second objective is to determine causal effects in the models for both groups and the lastly this analyses part is aimed to explore that whether all existing causes and effects are statistically significant for boys and girls. To achieve the first objective in multi-sample analysis, model 2 of figure 10.4 is run, this time for boys' and girls' samples. Following Table 10.8 presents the global indices for multi-sample model.

Indices	**Absolute**				**Incremental**		**Parsimonious**
	χ^2 (df)	Normed Chi-square	RMSEA (90% CI)	$P_{close\ fit\ H0}$	NFI	CFI	PNFI
Multi-sample statistics	581.622 (126)	4.616	.048 (.045-.053)	.628	.887	.901	.523

Table 10.8. Global fit indices for cause and effect model for gender

The fit index χ^2 = 581.622 is statistically significant and which is evident because for large sample it is sensitive thus a hostile evaluation of the model needs to consider other absolute and comparative fit indices (Hair et al., 2010). The absolute statistics for multi sample, $\chi^2_{(normed)}$= 4.616, is depicting that the model-2 in figure 10.4 excellently fits the data for gender, which means, this structural model equally fits the data of girls' as well as of boys' sample, that depicting that the same model of causal effects of exogenous variables in the development of attitude towards mathematics, is true for both boys' and girls' sample. In addition, incremental indices are demonstrating that approximately 90% improvement over that of the independence model fit (CFI= .901). Also the small magnitude of residual (RMSEA = .048) is also showing the acceptance of close-fit hypothesis (p=0.628). Moreover, the upper bound (= .053 at 90% confidence interval) of the RMSEA is also within the range and rejecting the poor-fit hypothesis. On the base of these fit indices, it is proved that the causal model, the one, which is obtained with marginally acceptance fit for whole sample, is in fact excellently fit for multi sample when tested separately for boys and girls. Moreover, from these results, the validity of model 2 in Figure 10.4 for gender in Pakistani culture is also supplied.

Nevertheless, this fact is indicating that there must be some moderations present in the model where gender differences are affecting, which in turn, decrease the acceptance power of our model when computed for overall sample. To study this phenomenon, for the next objective, the models are examined separately for boys and girls. Detailed description is given below.

10.8.1 Path Estimates for multi-sample (gender) models

Global indices for the multi-sample model are discussed above, now following the same multiple sample analysis technique, at the next stage, the significance of the cause and effect relationships mentioned in the form of paths, in the models, is examined for boys' and girls' sample. First, the model for girls' sample is presented along with the path estimates (standardized) and explained variance by each endogenous variable in Figure 10.5.

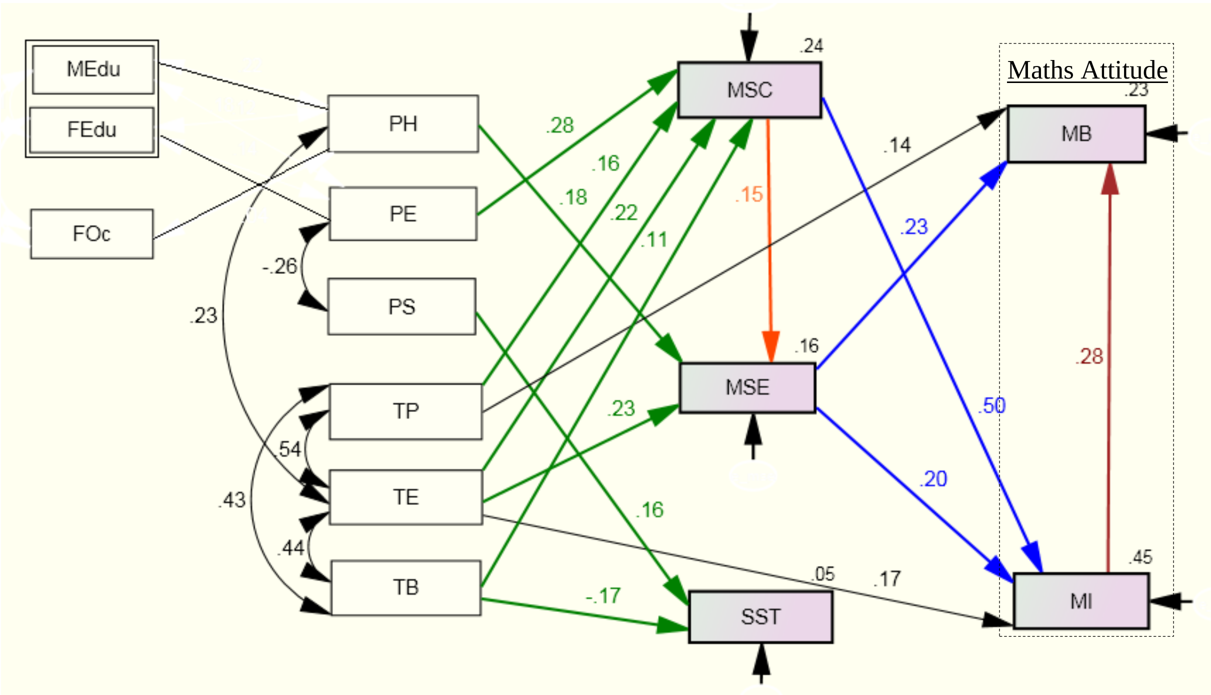

Figure 10.5. Cause and Effect model of mathematics attitude for girls

Apparently path coefficients for all cause and effect relationships and further the explained variances for the endogenous variables are indicating much similarity with that of model 2 in Figure 10.4. To examine whether each causal path in the girls' model is significant, as these were found significant in the constrained model in figure 10.4, statistical significance of these path estimates for girls' model are computed in Table 10.9.

Paths			Labels	Unstandardized coef. (β)	S.E.	t-values	Standardized coef. (b)
PH	→	MSE	b21	.138***	.028	4.964	.183
PE	→	MSC	b22	.430***	.053	8.069	.279
PS	→	SST	b23	.205***	.050	4.113	.156
TP	→	MSC	b24	.170***	.046	3.732	.161
TE	→	MSC	b25	.189***	.037	5.079	.221
TE	→	MSE	b26	.086***	.015	5.796	.232
TB	→	MSC	b27	.126**	.047	2.706	.110
TB	→	SST	b28	-.112***	.025	-4.496	-.174
TP	→	MB	c21	.168***	.045	3.719	.138
TE	→	MI	c22	.248***	.048	5.185	.175
MSC	→	MSE	d21	.064***	.017	3.819	.149
MSC	→	MI	d22	.826***	.054	15.29	.497

Paths			Labels	Unstandardized coef. (β)	S.E.	t-values	Standardized coef. (b)
						9	
MSE	→	MB	d23	.624***	.102	6.127	.234
MSE	→	MI	d24	.777***	.124	6.276	.202
MI	→	MB	d25	.191***	.028	6.940	.276

** p < .01; *** p < .001.
Note. 'b' is representing the direct path estimate of exogenous and mediator; 'c': exogenous to final endogenous and 'd' are between endogenous variables. While subscript '2' with each label is depicting that the estimate is for girl.

Table 10.9. ML estimates for model 2 (girls) of causal effect on mathematics attitude.

In Table 10.9, each path estimate is labeled in second column in order to compare boys' and girls' models. In table 10.9, t-values are demonstrating that in the model for girls, all causal effects are significant, further the magnitude of the significant effects are very much close to the constrained model. This fact is affirming that trimmed model 2 for whole sample in figure 10.4 is best fit model for girls' sample too, as no path is found non significant along with acceptable fit indices.

Now to have the causal effects for boys' sample, following the same analytical strategy just toggling the boys group, the model for boys is obtained along with the path estimates in Figure 10.6.

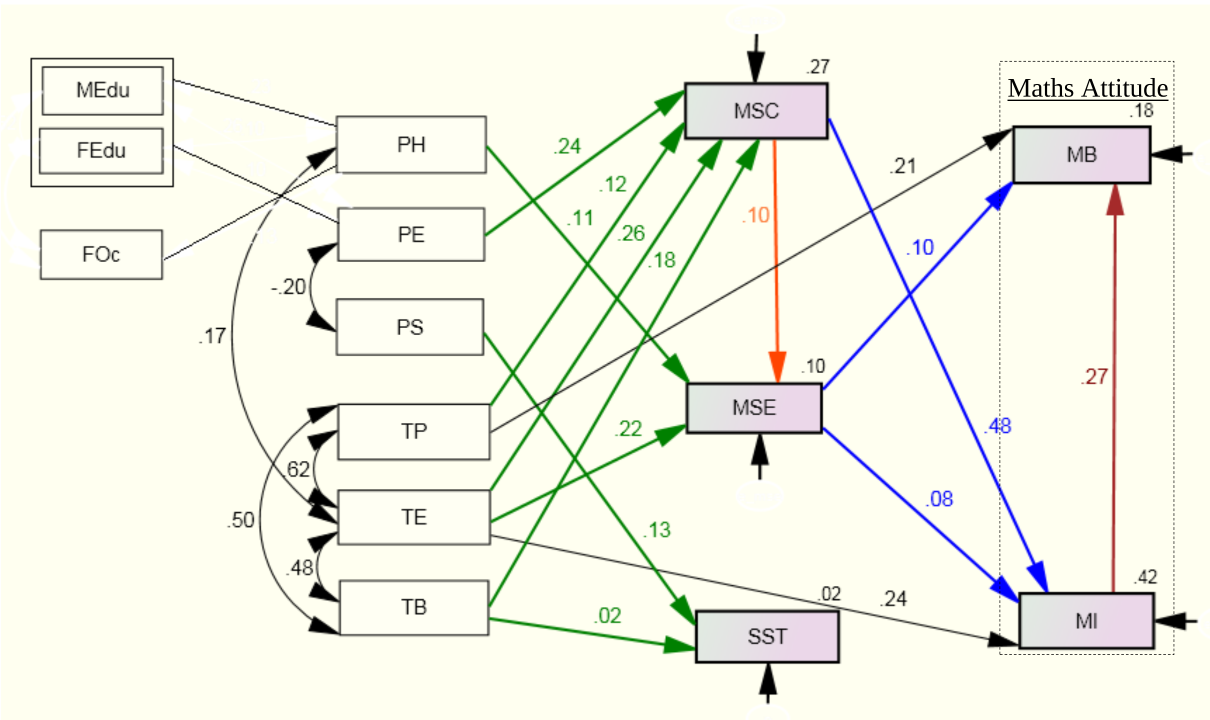

Figure 10.6. Cause and Effect model of mathematics attitude for Boys

Model for boys' sample in Figure 10.6 is showing few causal paths little different in terms of their coefficients as compare to girls' model. Too particularly, TB→SST (= .02) is depicting very weak effect for boys as compare to girls where it was found to be -0.17. Further, MSE→MB path is also indicating some difference between girls and boys, though variances explained by the endogenous variables in both models are seemed to be equivalent apparently. To verify whether these causal effects are statistically significant, regression coefficients (β), C.R along with t-values are computed in Table 10.10.

Paths	Labels	Unstandardised coef. (β)	C.R	t-values	Standardized coef. (b)
PH → MSE	b11	.088**	.027	3.233	.113
PE → MSC	b12	.358***	.046	7.759	.240
PS → SST	b13	.183***	.051	3.586	.128
TP → MSC	b14	.104**	.038	2.776	.117
TE → MSC	b15	.186***	.030	6.207	.259
TE → MSE	b16	.079***	.014	5.700	.219
TB → MSC	b17	.162***	.035	4.666	.175
TB → SST	**b18**	**.010**	**.020**	**.487**	**.018**
TP → MB	c11	.221***	.038	5.841	.210
TE → MI	c12	.279***	.038	7.331	.240
MSC → MSE	d11	.052**	.019	2.773	.105
MSC → MI	d12	.777***	.051	15.108	.480
MSE → MB	d13	.227**	.082	2.760	.096
MSE → MI	d14	.256**	.097	2.621	.079
MI → MB	d15	.195***	.027	7.180	.266

** $p < .01$; *** $p < .001$.
Note. 'b' is representing the direct path estimate of exogenous and mediator; 'c': exogenous to final endogenous and 'd' are between endogenous variables. While subscript '1' with each label is depicting that the estimate is for boy.

Table 10.10. ML estimates for model 2 (Boys) of causal effect on mathematics attitude.

All path coefficients (β) are found significant for boys model in Table 10.10 except b18 = 0.01. This shows that teacher behaviour has no significant causal effect on the stereotypic beliefs of boys, while, in the case of girls, this variable demonstrated a positive impact in reducing such beliefs. To have further deep understanding, direct, indirect and total effects of exogenous variables on endogenous variable for both girls and boys models are given in Appendix 3C and 3D.

To this end, model 2 in figure 10.4 is found to fit the data well separately for boys and girls, and further causal paths are also significant for boys and girls in their respective models. Now ahead towards the third objective of this part that, whether boys and girls differ significantly for these causal effects in developing mathematics attitude, respective path coefficients for each causal effect are compared in the following part.

10.9 Gender differences in causal relationships for mathematics attitudes development

Through multiple sample analysis, overall reflection of results indicate that all causal effects are statistical significant in order to predict mathematics attitude for both boys and girls. However, PB→SST is noteworthy between girls and boys models. Following the same multiple sample strategy, each causal effect is analysed one after other to examine whether significant gender difference exists for that particular causal and effect relationship.

But at first step, the hypothesis that, whether models for two groups (boys and girls) were statistically different is tested. For this, statistics for the fully constrained model[82] are computed which are found, $\chi^2 = 611$, (df = 140), $p < .01$. Previously, the model was trimmed by removing, if there was any, non-significant path in both boys' and girls' models and thus obtained the unconstrained model in figure 10.5 & 10.6. The fit statistics for this unconstrained model are already computed in Table 10.8 [$\chi^2 = 581.622$, (df = 126)]. To test the hypothesis that models are moderating with respect gender, a χ^2 difference test is applied on the fully constrained and the unconstrained model (Lomax, 1983). Results demonstrated that χ^2 difference test is statistically significant [$\Delta\ \chi^2 = 29.379$, (df = 14) at $p < .01$], confirming two models are different across the gender. Therefore, the assumption of "groups are invariant" is violated, thus, *path by path* analysis is required.

For doing *path by path* analysis, various hypotheses are developed concerning the causal effects to test in figure 10.7.

[82] This model, which had no equality constraints, serves as the comparison criterion for this part of analysis in this section after putting the equality constraints on the regression weights for finding the gender difference in the causal paths (Lomax, 1983).

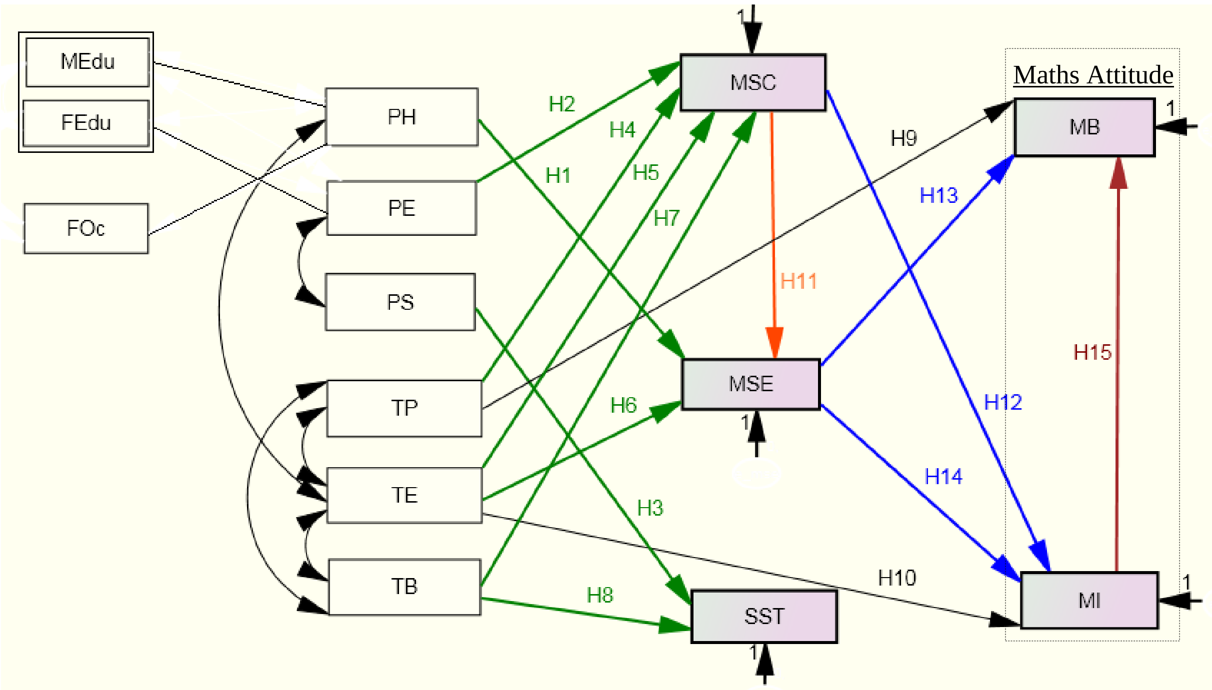

Figure 10.7. Hypothetical model for gender differences in cause and effect relationships

While testing statistically the hypotheses for the gender differences for cause and effects of variables, at next stage, these hypotheses are analyzed one by one with the assumption of invariant groups. For testing statistically a particular path for gender difference, an equality constraint is imposed on the particular path. For setting the parameters of interest equal, particular path is labelled with the same symbol separately for boys and girls model. Firstly, for the first research hypothesis that, there is no gender difference in the causal relationship of parents' help and mathematics self-efficacy, regression weight is labeled as "b"[83] in PH→MSE for both boys and girls model in order to put equality constraint for this path. Keeping other paths unconstraint, to measure the group invariance between boys and girls for path PH→MSE, the model was run. Model statistics were obtained, $\chi^2 = 583.126$, (df = 127), at $p < .01$. To test the assumption of the equal paths, a χ^2 difference test is applied on the unconstrained model and newly constrained model. The results show that hypothesis of equal causal effect, H_1: $b_{11}=b_{21}$ for PH→MSE, is accepted with non-significant χ^2 difference, $\Delta\ \chi^2 = 1.54$, (df = 13). This means that there is no gender difference for the causal effect of parents' help in the development of students' mathematics self-efficacy.

[83] However for sake of discussion and mentioning these path estimates in the table of hypotheses, the labels with subscripts given in Tables 10.9 & 10.10 are used to differentiate between males and females' estimates.

Second, the causal effect of PE to MSC is constrained to be equal between boys and girls. By following the same procedure mentioned above, value of χ^2 difference is obtained. The results indicate that the assumption of equal paths is supported by the data, with χ^2 difference test not being statistically significant [$\Delta\ \chi^2_{(13)} = 0.962$] at $p < .05$. Hence, for this causal relationship, PE→MSC too, boys and girls do not differ significantly.

In the similar way, all hypotheses for all paths are tested one by one in the model by following the same pattern and same value label across the gender and then compared the resultant models with unconstrained one by using χ^2 difference test. The values of constrained models against all hypothetical paths are provided in the table 10.11.

Hypotheses	Assumption	Constrained model statistics		χ^2 difference test	
		χ^2 value	df	$\Delta\ \chi^2_{(df)}$	Sig (p< .05)
H_1	$b_{11}=b_{21}$	583.126	127	$1.54_{(13)}$	p = .22
H_2	$b_{12}=b_{22}$	582.584	127	$0.962_{(13)}$	p = .32
H_3	$b_{13}=b_{23}$	581.723	127	$0.101_{(13)}$	p = .75
H_4	$b_{14}=b_{24}$	582.783	127	$1.61_{(13)}$	p = .28
H_5	$b_{15}=b_{25}$	581.626	127	$0.0045_{(13)}$	p = .95
H_6	$b_{16}=b_{26}$	581.732	127	$0.11_{(13)}$	p = .74
H_7	$b_{17}=b_{27}$	581.993	127	$0.371_{(13)}$	p = .54
H_8	**$b_{18}\neq b_{28}$**	595.836	127	$14.214_{(13)}$	**p = .002**
H_9	$C_{11}=C_{21}$	582.366	127	$0.744_{(13)}$	p = .39
H_{10}	$C_{12}=C_{22}$	581.884	127	$0.262_{(13)}$	p = .61
H_{11}	$d_{11}=d_{21}$	581.841	127	$0.219_{(13)}$	p = .64
H_{12}	$d_{12}=d_{22}$	582.054	127	$0.432_{(13)}$	p = .51
H_{13}	**$d_{13}\neq d_{23}$**	590.581	127	$8.96_{(13)}$	**p = .003**
H_{14}	**$d_{14}\neq d_{24}$**	592.433	127	$10.81_{(13)}$	**p = .001**
H_{15}	$d_{15}=d_{25}$	581.633	127	$0.011_{(13)}$	p = .92

Table 10.11. Gender differences in causal effects of mathematics attitude model

Though standardized coefficients for boys' and girls' models are slightly different for all causal paths in Table 10.9 & 10.10, but when tested statistically, only three paths out of total fifteen are found statistically different. Hypotheses mentioned in bold are the causal relationships in which boys and girls vary significantly.

In girls' model, MSC and MSE have more causal effect on the formation of attitude as compare to boys' model. In girls model MSE→MB = .23 & MSE→MI = .20, showed strong relationship than the boys where it is MSE→MB = .096 & MSE→MI = .079. On contrary, in boys model, teacher's direct effect on the constructs of attitude [TP→MB = .21 & TE→MI = .24] is found more strong than for girls' model where the amount of causal effect is, TP→MB = .14 & TE→MI = .17. This indicates an interesting fact that for girls, social factors influence more their mathematics self-beliefs, which in result develop their attitudes towards mathematics. While for boys, social agents like, teacher; directly influence student's interest and belief in mathematics although some part of this effect is also mediated through their mathematics self-efficacy but it is significantly less than that of girls.

On the other hand, MSC is appeared a strong influential variable for MI. Regression coefficients for causal effect of all teacher's variables have strong effect on MSC than MSE and in addition, both girls and boys are showing same intensity for these causal relationships in this cadre.

On contrary, positive relationship PS→SST is demonstrating that students' stereotypic beliefs are very much invaded through their parents. For girls, the causal path: TB→SST = -.17, is further indicating that teacher behaviour puts negative impact on the development on gender stereotypic beliefs. While for boys, the causal path: TB→SST = .02 on the other hand, is showing weak and non significant effect but possess positive impact, which means that, boys stereotypic beliefs (that is; "males are best in maths") somehow strengthen by their teacher's behaviour.

Moreover, causal relationship among mediators, the only causal relationship MSC→MSE is determined which shows that students' mathematics self-concept in fact generates mathematics self-efficacy in them, while its power is found little strong in case of girls than boys (d_{21}= .15 vs. d_{11}= .10 respectively). For the constructs of mathematics attitude, from the model-2 in figure 10.3, a strong causal relationship of MI on MB is discovered. In early model estimations, the reverse direction of causal effect were tested too, i.e., MB→MI, but it was found less effective than that of MI→MB. This fact indicates that within mathematics attitude, MI usually develops first, which later causes MB[84].

10.10 Advance model level 3 and degree 2 for teacher: A detailed model 3

General hypothesized model is showing the combination of fifteen variables in total. In the previous models estimations, "teacher" is found comparatively more influential variable for the development of causal effect on student's self-beliefs and mathematics interest and belief. Therefore, at level 3, the influence of teacher's pedagogical skill, encouragement and behavior is studied in detail with respect to the development of mathematics attitude in terms of its six dimensions. Therefore, to study the possible causal relationships between exogenous and outcome variables, bivariate correlations among them are computed below.

Descriptive statistics and correlations among the variables

The model at level three consists of total twelve variables. Therefore, spearsman's correlation coefficients among these variables along with their respective means and standard deviations are computed in Table 10.11

[84] Though two way process was determined but we limitized our model to recursive one for the present study, therefore reciprocal relationship is out of scope of this study.

Variables	M	SD	N	1	2	3	4	5	6	7	8	9	10	11	12
Mathematics Belief															
1. General Utility	11.63	2.23	1466	1											
2. Intellectual & practical	10.80	2.48	1443	.256*	1										
3. Personal/Financial	7.99	1.72	1473	.327**	.169**	1									
Mathematics Interest															
4. Enjoyment in doing	7.32	2.15	1471	.193**	.312**	.182**	1								
5. Value & Interest	11.30	2.25	1442	.192**	.227**	.151**	.197**	1							
6. Not Annoying	17.55	4.37	1417	.128**	.409**	.080**	.312**	.306**	1						
Teacher's Variables															
7. Behaviour	18.42	3.86	1402	.100**	.252**	.069*	.150**	.171**	.311**	1					
8. Pedagogical skills	24.67	4.07	1416	.168**	.361**	.159**	.254**	.207**	.391**	.478**	1				
9. Expectation	36.09	5.13	1399	.169**	.350**	.222**	.375**	.271**	.384**	.480**	.617**	1			
Self-Beliefs															
10. Maths Self-Efficacy	12.76	1.83	1455	.211**	.219**	.189**	.306**	.264**	.207**	.154**	.267**	.328**	1		
11. Maths Self-concept	18.59	3.99	1430	.076**	.362**	.088**	.296**	.309**	.627**	.368**	.408**	.448**	.260**	1	
Stereotypic Belief Variables															
12. Student's stereotypic perception	8.54	2.37	1455	-.022	-.068*	.007	.020	-.072**	-.048	-.109**	-.103**	-.019	-.046	-.088**	1

* $p < 0.05$; ** $p < 0.01$.

Table 10.12. Means, Standard deviations and Correlations of Mathematics Interest, Mathematics Belief, Mathematics Self-beliefs and Teacher's variables

The correlation coefficients among the variables in Table 10.12 are neither very high nor very low. Further, significant values are indicating that a causal relationship between the variables may be possible in the structural model. Like previous models, for this model-3 (level 3 & degree 2) too, after studying these significant correlations between the variables, paths between the exogenous and endogenous variables are drawn and run the model in AMOS by using Maximim Liklihood estimation. Various models were estimated with different specifications of the paths in the model-3 in the light of theoretical perspective. The one, with best-fit indices among various tested models, is presented in Figure 10.8. Absence of any path between the variables is indicating lack of significant direct effect.

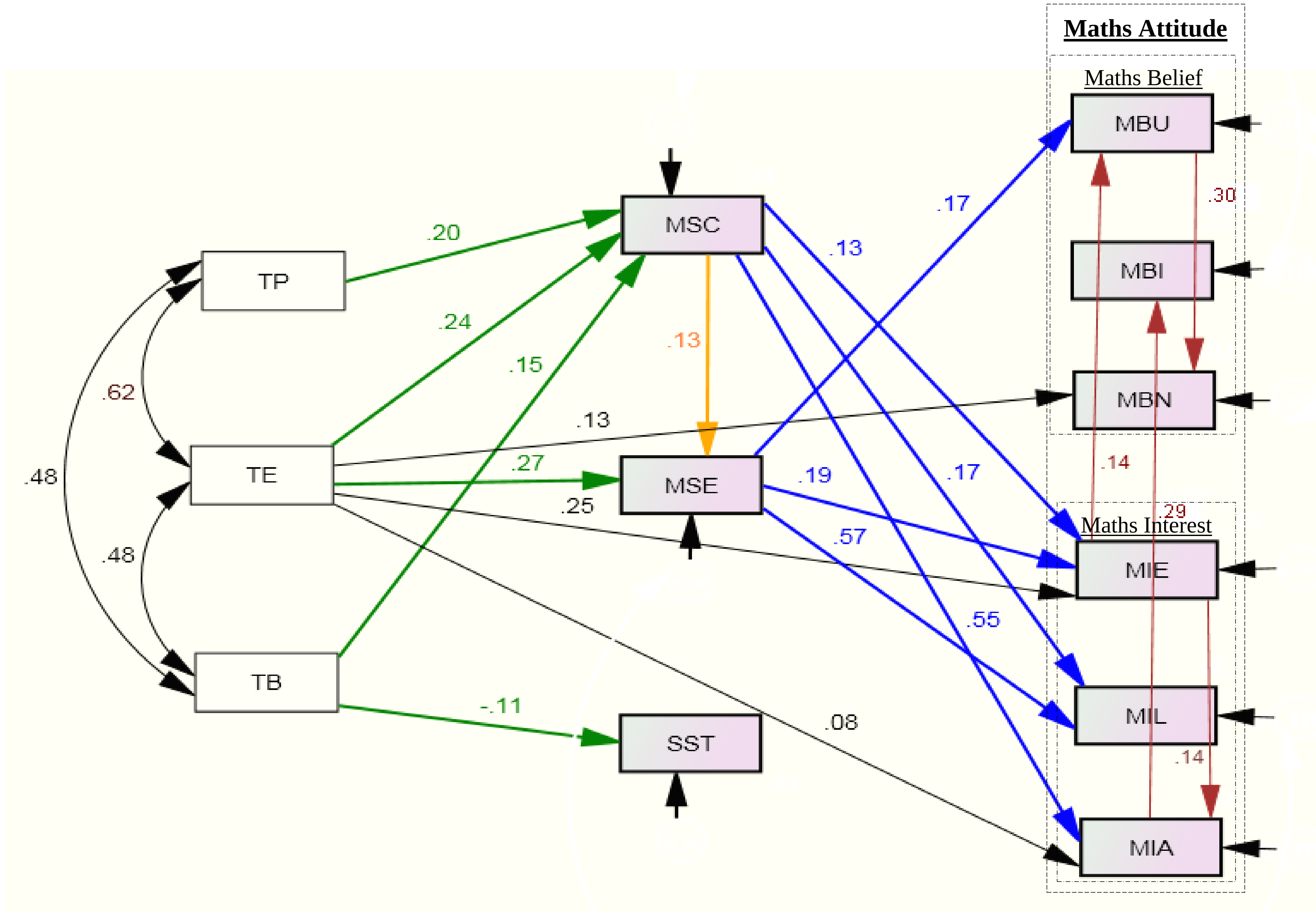

Figure 10.8. Model 3 (with degree two) of Teacher's Pedagogy (TP), Encouragement (TE) and Behaviour's (TB) causal effect in the development of Mathematics Attitude

All path coefficients in model–3 in Figure 10.8 are significant at $p < .001$. After estimation of this model-3, the discussion is proceeded in two steps first of the testing of the model and then the estimation of causal effects (direct, indirect and total) are presented.

Testing of the Model

The important absolute, incremental and parsimonious fit statistics are measured in Table 10.13.

Indices	Absolute				Incremental		Parsimonious
	χ^2 (df)	Normed Chi-square	RMSEA (90% CI)	$P_{close\ fit\ H0}$	NFI	CFI	PNFI
Teacher model 3	189.243 (39)	4.852	.048 (.044-.058)	.421	.951	.961	.476

Table 10.13. Model Fit Indices for cause and effect model-3 of Teacher variable

The Chi-square (χ^2 = 189.243) value for this model-3 is found non-significant at $p < .05$, as mentioned earlier that, this statitstics doesn't remain consistent in case of large smaple size (N > 200). Therefore, observing other goodness-of-fit measure at the place of χ^2 under absolute statistics, normed chi-square ($\chi^2_{(normed)}$= 4.8) is found within acceptable range. A smaller value of Root mean square residual error value is found and the null hypothesis of close fit is also not rejected at p = 0.421. This indicates that the model in Figure 10.8 fits the data well. Moreover, by studying the upper bound (= 0.058) of the interval at 90% confidence interval, it is verified that the value of RMSEA is also within the range and thus hypothesis of poor fit is rejected. In addition, the incremental indices are ensured 96% of the improvement that of the independent model of teacher's influence on the mathematics attitude. Lastly, less than one value of parsimonious index is strengthening the goodness-of-fit for the causal model of teacher's influence on the development of mathematics attitude in six dimensions, mediating through student's mathematics self-beliefs. However, to improve the model error correlations are added in the model.

Causal Effects (direct, indirect and total) of exogenous variables

In our previous model too, teacher's variables is appeared to have a strong causal effects on the endogenous variables. For level three, by removing parents' variables from the model, teacher's influence raised in its causal effect on the formation of mathematics attitude, directly or mediating through mathematics self-beliefs. All variance-covariance, multiple correlations and, direct, indirect and total effects of variables are given in Appendix 3E, here discussion on some prominent findings of the model-3 in figure 10.8 is done.

In the development of student's mathematics self-concept (MSC), all three variables of teacher; TP, TE and TB, are found playing significant role. Overall model-3 demonstrates that, teacher through pedagogy, encouragement and behavior develops MSC directly, and then mediating through MSC, is effecting indirectly MSE (mathematics self-efficacy) and causing interst in mathematics. All exogenous variables are developing MSC, indirectly through MSC. One unit of MSC has raised 0.13 units in MIE (Enjoy doing maths), 0.17 units in MIL (like mathematics) and 0.55 units in MIA (maths is not annoying). On the other hand, regarding direct effect on MSE, only TE is found to develop a direct causal relationship with it. One unit of TE increases 0.27 units of MSE. Moreover, TE also develops a direct causal relation with mathematics attitude's sub-variables: MBN (= 0.13), MIE (= 0.25) and MIA (= 0.08). This shows that teacher through her or his encouragement can enhance the positive attitude in students. Regading the direct causal effect of MSE, or indirect effect of TE and MSC on mathematics belief, one unit of MSE has raised 0.17 units in MBU (Maths Global utility belief), 0.19 units in MIE, while for MIL it is found 0.57.

Whereas mediating variable SST (stereotypic beliefs) in this model too, has not developed any causal relation with mathematics attitude but a negative and non-significant causal effect is found on MSC. A negative effect of teacher's behavior depicts that perception of teacher's positive behavior can reduce stereotypic belief in students significantly.

Concerning the observation of causal effect within six dimensions of mathematics attitude, MIE is appeared as a strong dimension, which has developed a direct causal effect on MBU and MIA and indirect causal relationship with MBN and MBI. If keeping the causal effect of MSE constant, then one unit in MIE raises 0.14 units in MBU and indirectly mediating through MBU causes 0.1 (cf. Appendix 3E). On the parallel side, one unit of MIE enhances 0.14 units of MIA and indirectly 0.15 units in MBI.

At the threshold of these findings of teacher's influence model in Figure 10.8, it can be concluded that the students' perception of teacher related variables (pedagogy, encouragement and behavior) directly develop mathematics self-concept in students, which later creates a direct causal relationship with all three defined dimensions of mathematics interest and enhances the mathematics self-efficacy on paralle side. However, perception of teacher's encouragement also causes direct effect on the mathematics self-efficacy, which helps in developing students' belief in mathematics global utility, and enjoyment and liking of mathematics. While, the third mediating variable stereotypic belief, that is found to have positive causal impact from teacher's behavior, couldn't develop significant relationship with either of the endogenous variables. And lastly, within mathematics attitude, the dimension of enjoying doing mathematics is found more influencing variable that influence directly and indirectly other dimensions of mathematics attitude.

After the data analysis and results of the present research, next chapter, the last chapter of this section and thesis, is addressing the discussion on these obtained results and conclusions of this research study.

Chapter 11. Discussion and Conclusion

11.1 Introduction

The underlying assumption of this study was in general, that, students' perception about their capabilities develops under the influence of cultural norms, societal needs, educational environment, and social expectations. Therefore, when the question of studying the sentiments, beliefs, and intentions of a student towards learning mathematics arises, then a deep insight of cultural settings in which a student lives, develops his mode of thinking and future expectations is obligatory to take into account. As the culture, societal setup and educational environment in Pakistan is different as compared to other parts of the world (including westren and Anglo-Saxon countries). Therefore, this study was focused to explore the formation procedure of students' attitudes towards learning mathematics, and the influence of their perception of the social factors on it, in the scenario of Pakistan. Besides, aim of this study was to enhance this idea and stimulate discussion in mathematics education in Pakistan where such research should be conducted more.

The findings of this study, when taken collectively, provided a strong reflection on the hidden strands for developing and strengthening the study of mathematics attitude into this particular domain of study, i.e., mathematics education. This chapter discusses the findings of the present research and summary, which can be divided broadly into four tiers that starts from the theoretical framework of mathematics attitude (provided in chapter one and two) and ends at the structural model of mathematics attitude development (chapter eight to ten). In addition, this chapter is focused on the conclusions that are made in the light of the reflection of the results for the research questions and the recommendations for future research.

11.2 Theoretical framework of mathematics attitude and theoretical model

Generally speaking, the first objective of the present study was conceptualization of the mathematics attitude. As highlighted by the researchers (Hunnula 2002; Zan & Martino, 2007), quoted earlier in chapter one, that less work was done in the premises of epistemology of this concept, while most work was done in the measurement of mathematics attitude even without defining this term. Therefore, this study has taken a deliberate attempt to provide the theoretical framework of this concept and offered a multidimensional view of mathematics attitude within the boundaries of cognitive and affective domains. In mathematics education, affective domain in terms of sentiments is either addressed to call it as an attitude[85], or cognitive domain is focused to explain it in terms of belief, and measured this construct accordingly. Research studies[86] provided such instruments to measure mathematics attitude in which attitude is mentioned in a single score, and thus on the bases of this collective score, it is decided that whether a student had a positive or negative attitude. Due to this, there are the possibilities that some aspects might remain hidden that may represent some particular inclinations of students in some items, when represented mathematics attitude as a single entity. Thus to encompass it, current research has tried to present this concept in a multi dimensional approach, and thus this term is defined it into two constructs: interest in mathematics and mathematics belief. These constructs are further fragmented into six dimensions to examine mathematics attitude in more explorative form. These six dimensions included three dimensions; "situational interest", "value perception and liking", and "agreeable feeling", were measuring interest in mathematics. And, the other three dimensions; "global utility", "intellectual and practical importance", and "personal need" belief were measuring mathematics belief.

Second principal objective of this research was to conceptualize the formation process of mathematics attitude. In the light of literature review, present study proposed that, students' attitudes towards mathematics depend on the various factors. Based on this reflection, a theoretical model was proposed, through which an attempt was made to show the formation process of attitude of a student towards learning mathematics. Among the factors mentioned in this model, it was then explored a few in the result of preliminary survey. On the basis of theoretical model and factors explored in the result of preliminary survey, a hypothetical model was developed. It was hypothesized that, students' evaluative inclinations, feelings, and perception about mathematics, in general, and about their capabilities to do mathematics in particular are the results of their private knowledge. This private knowledge constructs as a consequence of communication with inter-personal, psychological and social factors (including parents and teacher). Whereas, student's past affective reactions concerning mathematics provides basis to constitute the feelings

[85]Frenzel et al. 2010; Krapp et al. 1992; Zan *et al*. 2006.

[86]For example, Fennema (1976) proposed 98 items scale to measure mathematics attitude and influence of social factors.

(negative or positive) and intentions to learn mathematics. In addition, the memory of prior beliefs, she or he has about mathematics and her or his capacities transferred by the parents and teacher, are the determinants of her or his mathematics attitude.

11.3 Findings of Preliminary survey and Instrument development

The last two tiers of this study were based on the research work. First one dealt with the instrument development on the base of findings of preliminary survey conducted on the university students. The last principal objective was the validation and estimation of the proposed theoretical model of the study.

In the development of appropriate scales to measure students' mathematics attitudes, the results and findings of this preliminary survey, where served as the bases for the instrumental development, it also provided the reflection on the students' intentions, expectations and barriers in advance level of mathematics. On the one hand, these findings revealed that in Pakistan's context, intention and decision of student to continue mathematics in advance level depends mostly on the educational facilities, opportunities, home background and parents' socio-economic status particularly parents' education. On the one hand, these findings further strengthened the propositions of theoretical model in which it was assumed that parents' factors may have direct causal effect on the development of mathematics belief of students, specifically belief of financial help and self recognition through mathematics. This concurs with what has been explored by McGrath & Repetti (2000) that, there is a direct link between the perception of students about social agents (parents) and their attitude towards mathematics. Regarding mathematics teacher, the findings of pre-pilot survey indicated that teacher with her or his behavior and teaching competencies can bring the students towards learning this discipline. But some students also mentioned that they never found any good mathematics teacher, which also worked as a motivation to study this discipline to provide a good mathematics teacher to society.

Concerning the scales development, care was taken that these scales should address factors, styles and language, which are prevailed in Pakistani society. In the result of qualitative data analysis of preliminary survey, items bank consisted of 89 items, was generated for four scales; aimed at measuring the perception of students' about "parents' influence", teacher's effect, mathematics self-beliefs, and mathematics attitudes. A 5-points

Likert's scale was adopted for these scales, and later these scales were refined through content validity. Further to extract the factors and measure reliability of these scales, by using SPSS v.17, exploratory factor analysis and Cronbach's Alpha were applied on the data of the pilot study, conducted in three cities; Islamabad, Lahore and Sargodha. As a result, total 57 items were left that were distributed in four scales, while an additional scale "Males are best in Maths" was also included.

Later, in the context of the last objective of this research study, that is, model estimation and validation, these instruments were administered on 1499 students (678 Girls & 821 Boys) from ten urban schools (public and private) of two cities, Lahore and Sargodha, in the final survey. Data was analyzed through SPSS and AMOS v.18 software. The findings for our research questions are presented below.

11.4 Findings of Research questions and conclusion

In the first part of data analysis, four major research questions were dealt on measuring the differences among the students. Descriptive statistics from the final data revealed that students showed overall positive attitude towards mathematics. Following the first research question of gender differences in mathematics attitude of Pakistani students, the findings showed that, boys and girls were not found statistically different in their attitude towards mathematics. In addition, with respect to the constructs of mathematics attitude too, no gender difference was found. But significant gender differences were found when mathematics attitude was analyzed with respect to its six dimensions. In MI_Enj measuring the dimension "enjoy doing mathematics", boys demonstrated significantly more positive attitude than the girls. This finding of the present study supports the findings of the previous studies of Blondin & Lafontaine, 2005; Fennema, 1981; and TIMSS 1999. The other variable, MB_Need measuring mathematics belief in its utility of financial and self-recognition was found, in which girls demonstrated significantly better attitude as compare to the boys. This finding is somehow confirming the findings of Iben, F (1991), Geary (1994), and Brown & Walter (2005), who found that deprived group, ethnicity wise or on the base of gender, appreciate the usefulness of mathematics more. This was an interesting finding because as observed in available statistics that the number of girls decreased by 50% after primary school in Pakistan (Ahmed, 2006; Farooq, 2009). Therefore, it can be deduced on the base of these findings that, girls who are lucky enough to continue their studies at secondary level become more serious and aware of the usefulness of mathematics for their future careers. On contrary, boys did not show a high level of agreement for this. A possible reason may be that, boys may have access to other opportunities to earn money to meet their educational expenses, rather than choosing mathematics, while for girls in Pakistani society, among the possible opportunities, teaching is the one, in which they may have easy access to earn some money. As observed in Pakistani society that parents generally tend to spend more money, even if they are living hand to mouth, for the education of their sons rather than their daughters (PSLM, 2008; Aslam, 2008; Qureshi, 2003). Therefore, by giving private coaching, girls can earn some money to meet their expenses. The other possible reason that can be deduced from these findings is the sense of self-independency, which perhaps boys do not lack in but girls lack in many situations especially in Pakistani culture.

The second research question was to explore the effect of the age in the development of mathematics attitude. To achieve this objective, differences between grade six and grade nine students were analyzed. Results suggested that students, as they grow up, strengthened their attitudes towards learning mathematics. Students of grade nine mentioned significantly positive attitude, as well as more interest and belief in mathematics than the students of grade six. Finding of this research further suggested that within the dimensions of mathematics attitude, particularly in belief that mathematics enhances intellectual development, and the all three dimensions of mathematics interest, elder students demonstrated significantly more positive attitude than the younger students. Perhaps the possible reason may be that, with age, students get mature in their vision also and they become more aware of the practical and future life demands, and as a result, their interest in this discipline also increases. However, in the dimension mathematics need belief, students of grade six demonstrated significantly more positive attitude than the students of ninth grade.

After these findings of gender and age difference, the next research question investigated was, whether gender and grade interaction was significant when studied with respect to the mathematics attitude? Findings reveal that gender and age do interact in the development of attitude towards mathematics. Though boys at both grade levels showed little more positive attitude than girls but, neither boys of sixth and ninth grades were found significantly different nor the girls of both grades in mathematics attitude. This means that across the years, mathematics attitude get strengthen but this increment is not found significant for age period 11 to 14 years. Moreover, in the terms of components of mathematics attitude, Findings reveal that gender and age was not found significant for mathematics belief. Whereas regarding the construct mathematics interest, both boys and girls of ninth grade showed significantly more interest than their counterpart boys and girls of sixth grade. However, boys at both grade levels were holding more interest than girls. These findings were very much similar to the findings of the studies of Ceci et al., 2009; Croizet et al., 2001; and Muzzatti & Franca 2007, in which girls showed less interest in mathematics especially after fifth grade as compare to boys.

When gender and grade interaction was investigated for the dimensions of mathematics attitude, under mathematics belief, in variable "mathematics belief of intellectual development", interaction between gender and age was found significant; girls showed a decline in this belief as they moved to advance grades, while boys demonstrated a significant rise as they moved from grade six to nine. In case of variable "mathematics need belief", situation was opposite; more boys than girls declined significantly in this belief when moved to upper grades. On the other hand, under mathematics interest, findings depicted that gender and age interaction was significant for the variable "enjoy doing mathematics" only. Though at grade six, boys showed more interest but at grade nine, girls showed more interest than girls of 6^{th} grade, as well as than boys of the same grade but this change with respect to age was found significant for girls when investigated for all four groups. This finding further strengthened our assumption that if girls get opportunity to get education up till this level and moreover, if they choose science stream, they manifest more commitment and devotion than boys towards education too particularly towards mathematics.

The last research question for this part of analysis was to investigate that, do parents' education and nature of profession as the indicators of socio-economic status develop mathematics belief in students, particularly in mathematics need belief? According to the results, this belief was found significantly more positive among the students belonging to fathers having no education or primary education. In other words, the findings for this question suggested that father's high level of education causes a decrease in this belief among students and this decline was found more among boys than girls. Further, with respect to grades, comparatively younger students demonstrated constant situation across the father's education levels but ninth grade students showed decline in case of father's better education level. The similar pattern of findings was observed in case of mother's education too. Boys showed more decline in this belief in case of well educated mothers but interestingly, in case of girls this need belief remained constant or rise in case of mother's better education level. This finding also suggested that mother's education appeared a source of motivation for girls towards mathematics regarding this particular dimension as compared to boys where it was found diminishing as level of mother's education increased.

In the same category of socio-economic status, the next variable "father's occupation" was analyzed. Though, no significant difference among the students was found with the respect to the nature of the father's occupation. However, students from "father with teaching profession" were showed comparatively more mathematics need belief. Hence, findings for this research question affirmed our assumption that low level of socio-economic status of parents elevates the urge and need of money and self-recognition. And having belief that mathematics can be the source to fulfill this need may then accelerate among the students belong to such families. In other words, girls' high and consistent belief in this particular dimension demonstrate that deprivations in life due to low socio-economic status or societal constraints may also enhance their motivation to get education and move forward to earn get their self-recognition through secure way like teaching. Whereas, in case of boys, a diminishing pattern in case of high level of parents' education (especially mother's education) indicates that well educated parents either do not transfer this belief or they provide facilities and vision to precede this discipline for other reasons.

11.5 Model discussion and conclusion

At the last stage, towards the validation of the theoratical model, the hypothetical general model (recursive) at level one (collective effect of all factors under each variable) was estimated by using path analysis in structural equation modeling. The results for this model [χ^2=1.695 (df=1), normed chi-square = 1.695, NFI = 0.999, CFI = 0.999, RMSEA = 0.022] indicated that the theoretical model presented in this study does exist. The findings demonstrated that perception of a student about the help and encouragement of parents and his/her mathematics teacher have the causal effect on the development of his/her mathematics attitude. Next, model at level-2 and degree-1 (with 6 exogenous sub-variables, three mediating variables and two endogenous variables under mathematics attitude) was estimated. This model-2 with the addition of parents' education and occupation was found with good fit [$\chi^2_{(normed)}$=6.14, NFI = .907, CFI = .919, RMSEA = .058]. The findings for the causal effects suggested that perception of parents' expectation caused directly student's mathematics self-concept and their help had causal effect on the development of mathematics self efficacy. These effects then developed mathematics attitude. These findings affirmed the conclusions of the studies of Alliman-Brissett & Turner (2010), Fennema (1977), Eccles et al. (2007), and Musen-Miller & Blevins-Knabe (1998), who also indicated parents' expectations and interest as the influential variables in the development of students' perceptions about their capabilities. On the parallel side, this model indicated that perception of teacher's pedagogy, encouragement and behavior directly affected student's mathematics self-concept which caused later mathematics self efficacy. Further, teacher's encouragement was found to affect directly mathematics self-efficacy and mathematics interest as well, whereas perception of teacher's pedagogy produced a direct causal effect on mathematics belief. These findings were found similar to the earlier studies concluded by the researchers (Lester et al., 1989; Pehkonen, 1994; Thompson, 1992).

In addition, this model explored within endogenous variables that, mathematics self-concept developed a significant causal effect on the development of interest in mathematics, while mathematics self-efficacy was found to affect both mathematics belief and interest within mathematics attitude. Regarding this causal ordering, researchers, earlier in their studies[87], found causal order from achievement to attitude in mathematics. But where stands mathematics attitude and self-concept in a causal order, this fact was explored in the present study that, this is the mathematics self-concept that determines mathematics attitude. Further in present research, this causal direction (mathematics self-concept to mathematics attitude) was found more predominant as compare to mathematics attitude to mathematics self-concept.

Another interesting fact was discovered from this research that, mathematics interest was more independent construct within mathematics attitude, which caused mathematics belief. From this research, it is further discovered that mathematics interest developed causal effect on belief in mathematics. Thus, in the development process of mathematics attitude, interest in mathematics as the affective component develops first and with its causal effect, it determines mathematics belief as the cognitive component. This finding is contrary to that of McLeod (1992), Ma & Xu (2004a), whose findings were the causal predominance of cognitive over affective component.

In addition, within mediators, the variable "students' stereotypic beliefs", based on the scale "males are best in mathematics", was directly influenced by the parents' stereotypic beliefs. Though this mediator couldn't establish a significant causal relation with

[87] Wyne, 1979; Ma & Xu, 2004a.

mathematics attitude, but it developed a negative effect on the mathematics self-efficacy of the student. However, estimate coefficient of this effect was not found significant. These findings demonstrated that students conceive gender stereotypic belief in them usually from their parents. These findings are supporting the findings of Jacobs et al. (2005) and Neuenshwander et al. (2007). They indicated that parents' own belief in gender roles define social-environment of home where a child is reared up and such gender-biased beliefs automatically penetrate in them, and then they would see themselves through gender-polarizing lens.

Further, to study whether these causal relationships in our model-2 are gender invariant, a multi sample technique was adopted. The findings of the global fit statistics demonstrated best-fit model for gender [χ^2= 581.622 (df = 126), normed chi-square = 4.6, NFI = 0.887, CFI = 0.901, RMSEA = 0.048]. In the model of boys, the prominent finding was the predominance direct effect of the parents' and teacher's variables on the mathematics interest and mathematics belief, while in the model of girls, the indirect causal effect of parents' and teacher, mediating through mathematics self-beliefs, on mathematics belief and interest was found predominant. This variation suggested that in case of girls, causal order of exogenous variables (parents and teacher) affects strongly mathematics self-concept and self-efficacy. Whereas in case of boys, causal effect of exogenous variables influenced directly mathematics attitude. Moreover, findings regarding gender difference showed that the causal relation of teacher's behavior and student's stereotypic beliefs in case of girls was significantly more positive impact than that of boys. This fact further strengthens the findings of this research that girls take more effect of parents and teacher on their mathematics self-beliefs than boys where it seemed not much affected. Further, the positive causal effect of parents' stereotypic beliefs and students' stereotypic beliefs, both for boys and girls, demonstrated that both boy or girl feels mathematics is for males if their parents think so, which is very similar to that of Bornholt's (2000) conclusions.

Concerning the dimensions of mathematics attitude, in model-3 and degree-2, the findings of the estimation of the model at advance level, particularly regarding teacher's influence, demonstrated a best-fit model 3 [χ^2= 189.243 (df = 39), normed chi-square = 4.8, NFI = 0.951, CFI = 0.961, RMSEA = 0.048]. Mathematics self-concept developed a strong causal effect on the three dimensions of mathematics interest, among them, the variable "mathematics is not annoying" was found to have most strong effect, both direct and indirect, passed through "enjoyment" variable. Further, findings for this model-3 demonstrated that mathematics self-efficacy could develop causal relationship with global utility belief within the premesis of Mathematics belief only which was later translated to need belief. This finding infers that one should have the knowledge of global utility of mathematics in order to develop the need belief of mathematics. Whereas, mathematics belief of “intellectual development (MBI)” usually develops when mathematics does not annoying for a student. In this model another interesting fact was revealed that teacher’s behavior developed a negative effect on student’s stereotypic beliefs (SST). This finding depicts that teacher’s positive behavior reduces the negative impact of stereotypic beliefs in students.

In addressing the question of formation of attitudes of students towards learning of mathematics, a number of factors were studied to understand the developmental process of mathematics attitude. Under the influence of social agents (parents and teacher), the causal relationships between the variables (endogenous and exogenous) were explored in the light of students’ perceptions of these variables. In order to explore student’s engagement with mathematics, it was examined in the current study that how these perceptions of students alter with respect to gender and environment, based on parents’ education level and nature of their occupation. This research concluded that a greater proportion of the differences in mathematics attitudes of students regarding their gender is caused by the societal needs and expectations developed by parents who also sometimes invade stereotypic beliefs, and thus, affect boys and girls in different ways. Moreover, this student enters in the classroom with subjectivities of beliefs, and certain level of confidence based on her or his experiences and background variables. In the classroom, mathematics teacher with her or his pedagogy, encouragement and behavior, mediating through student’s mathematics self-beliefs, alters or strengthens the intensity and direction of student’s engagement with mathematics. In addition, concerning the research hypotheses within the general model of all variables, it is revealed that mathematics teacher affects more significantly students’ mathematics self-concept and self-efficacy than parents, whereas parents’ stereotypic beliefs cause stereotypic beliefs in students.

Further, in terms of constructs of mathematics attitude, the causal order was found better from mathematics interest to mathematics belief. This means, in the formation of mathematics attitude, affective component develop cognitive component more significantly. This finding contradicts with the results of previous research studies (McLeod, 1992; Ma & Xu, 2004a), which explored the sequential order from cognitive towards affective component. In addition, due to the dimensional concept of mathematics attitude, proposed in this research, this study has offered the chunks of thought to study this concept at micro level. Within the dimensions of mathematics attitude, “enjoy doing mathematics” is found most influencing dimension, which influenced directly and indirectly the other dimensions of attitude. This shows that if a student is lacking in this primary dimension, she or he may not keep her or his attitude positive and strong towards mathematics.

However, these conclusions carried by this research open a new horizon in this field of study to revisit the concept of mathematics attitude at micro level, too particularly, in the dimensional form. Because research literature indicated boys’ positive attitude more than girls, when measured this concept in macro form, that is, as a one-component or two-component based term. But if all these research studies, which indicated positive attitude of boys, could be revised by taking dimensional concept of mathematics attitude, would the results be same?

Further, these results may be useful in exploring the issue of low participation of girls in mathematics at advance level too. Because the gender difference in this study revealed girls’ more positive attitude in terms of mathematics need belief, while, boys demonstrated more positive attitude in enjoying doing mathematics. Therefore, if we correlate the fact of underrepresentation of females in mathematics, cited in literature, with the reflections of this research, then can we say that, this belief construct is temporary? Is this mathematics belief, after sometime, diverted for some other discipline? Whereas, interest in mathematics, which is demonstrated by boys, is more consistent and durable component of mathematics attitude? Moreover, does it mean that, the element of enjoyment, under the interest component, is due to the societal circumstances and oppurtunities that the boys are previliged with in the society?

In addition to these questions, will the research demonstrate similar results, if all the girls and boys would have same oppurtunities and access to higher education? Studies in these contexts, along with the combination of other important factors like, role of peer and friends, school systems, past achievements, socialization of student, social acceptability of females in science etc., no doubt are pertinant to conduct, especially in the context of Pakistan; the country which is passing through the transitional stage confronting both traditionality and modernity.

In the light of the findings and conclusions, present research suggested few recommendations for general policy improvement and teachers' training proagrams, and for the future research in this field of mathematics education, which are presented below.

11.6 Recommendations

Recommendations to improve policy implementation and teachers' training programs:

- Pre-service mathematics teachers' training programs need to empower with awareness of language and practical application of mathematical concepts, which are compatible with each grade in the school. Because mathematics is not merely the learning of formulae or solving the mathematical problems by following some set rules, rather it is the discipline that develops the direct relation with daily life matters. Therefore, school mathematics should be synchronized with the implementation of practical life's examples.

- In Pakistan, no training program for teachers exists for teaching primary mathematics in government teachers-training institues. Findings on the basis of the observations during the surveys in the schools (also in universities during informal discussions with students) revealed, that the conceptual gaps in mathematics, developed in early years of school, usually provide the bases for avoidance of mathematics in later years. Because after grade four, mathematics based on calculations and measurements usually convert into computational and then problem solving format (little abstract concepts are introduced after fifth grade in Pakistani curriculum). Therefore, bookish knowledge, and further, transferring it in traditional teaching style becomes the source of losing interest in learning mathematics, and generating conceptual gaps in students. Hence, it is highly recommended to take initiatives to introduce primary mathematics teacher training programs too.

- As observed during survey regarding the technology-based item, that students didn't know why and how mathematics is important for technology. Therefore, in the light of the observations in this research, it is urged that Mathematics curriculum prevails in Pakistan should be invigorated with the modern advancements in mathematics contents and concepts in order to strengthen the mathematics belief. Too particularly, practical implications of mathematics in modern technology, keeping in view the demands of Pakistan’s requirement of human resource should be fostered.

- In order to develop students’ mathematics interest, reforms in mathematics curriculum should also be introduced in the light of international standards. Further, more emphases should be given on the concept formation rather than strengthening the procedure only to have correct answers of the problems.

- Modern technology should be adopted to bring colors of variation in mathematics. Animated softwares (like; computational mathematics games, Math-Teacher software, Cabri, etc.) and project methodologies need to be practiced in schools. Further, special support needs to be planned and organized by schools for students who are either slow learner or having conceptual gaps in mathematics, which later becomes the cause of mathematics avoidance or failure.

Recommendations for future research:

- One of the main features of this study was its research design; both qualitative and quantitative methodologies were adopted. Due to which, a better analysis of the problem could have possible. Nevertheless, some traces of the problems are remained that need to be explored further, most probably by using interviewing technique that, why girls preferred mathematics to satisfy their financial and self-recognition needs. Further, the variable SST couldn’t develop causal relation with any endogenous variable, but kept in the model was also evident. Therefore, to explore this variable, by using it as moderator or discovering some connection with future life plans of students, can explore the reason of under representation of the girls in mathematics and engineering (which is not more than 17% till date).

- A thriving feature of this research was the pre-pilot survey, which was conducted on the university students for the sake of instrument development. In this survey, it was unveiled that mostly girls continued mathematics because of the family element; either father asked or brother was already in the same domain. This fact provoked that present research needs to be conducted further on higher secondary levels too, in order to address the question of less interest, and thus low participation of girls in mathematics can have some answer.

- This research was conducted with the cross sectional data to study the effect of age on the students in the formation of mathematics attitude. However, in order to explore the change in causal order of the exogenous variales and their effects on the development of mathematics attitude across the years, it is highly recommended to conduct the study on the longitudinal data.

- Earlier studies established the causal order of achievement onto either mathematics attitude or self-concept. Moreover, the predominance of cognitive over affective component was also reported in research. However, present study explored the causal order of mathematics interest over mathematics belief, that is, affective over cognitive. Therefore, for future research, by adding mathematics achievement as an additional variable, this causal order needs to be studied.

- This research proposed a six-dimensional approach of mathematics attitude, which was tested in causal model too. However, other forms of mathematics belief and interest are still left to address, presented in first chapter of this thesis. Therefore, in order to figure out the students' problems of negative or low attitude towards mathematics, other variables, measuring these forms, should be developed. Moreover, the causal effect among the dimensions of the mathematics attitude needs to be analyzed independently in order to refine the premises of this concept.

- This research further recommends for future study, that the causal relationship of all six dimensions of mathematics attitude in relation with the conceptual clarity of the students in various domains of mathematics, needs to be studied to discover the relationship between the developmental procedure of attitude and formation of concept.

- Although, under the socio-economic status tag, parents' education and occupation were utilized as the exogenous variables in the causal model of mathematics attitude. Multivariate analysis of the data revealed that students belonging to different socio-economic levels were significantly different in mathematics belief. Thus, it is suggested for more trials, that causal models of this study should be analyzed by introducing parents' education and occupation variables as moderators to observe the effect of causal order in the development of mathematics belief.

- Students from two cities participated in this study, therefore, on the one hand, to strengthen the validity of the instruments developed for this study, and on the other hand, to examine the students' attitude in other cities and villages, these instruments should be administered in other parts of Pakistan too.

- Last but not least, the prime objective of this research was to explore the causal relationship among the student's perception of social agents (parents and mathematics teacher) and student's self-beliefs variables in the formation of her or his attitude towards mathematics. To achieve this objective, a few but important factors were contemplated, which were highlighted in extensive literature review to study this causal relationship. However, at the same time, it is also a fact that educational facilities, easy access to educational institution, availability of mathematics teacher, etc., are such variables whose worth cannot be denied in the successful process of learning. As mentioned in the survey PSLM 2006, that many parents indicated their fear of sending their daughters to schools far from their homes due to security reasons. Further, mostly boys left education to earn livelihood, and girls to help mothers in homes etc. There may be number of other factors too, which contribute as the hidden hurdles in effecting the causal relation among the variables in the development of attitudes towards learning and continuing mathematics sciences or even continuing simple education. Moreover, mathematics teacher's own limitations, workload, students-teacher ratio, her or his assessment of students' abilities, etc., are another stream of the influential factors. Therefore, addressing these issues at micro and macro, in both contexts, for understanding the development of attitudes towards learning mathematics are additional routes for future research.

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APPENDICES

APPENDIX-1

Key Terms

Mathematics Self-Concept

Mathematics self-concept is student's confidence in learning mathematics and to excel in it.

Mathematics self-Efficacy

Mathematics self-efficacy is the perceived ability of a student to solve mathematics problems correctly at hands.

Teacher's Pedagogy

Student's perception about her/his teacher's mastery in content knowledge and pedagogical skills to teach mathematics interestingly.

Teacher's Encouragement

Student's perception of teacher's psychological support, motivating feedback and high expectations for her/him in mathematics.

Teacher's Behavior

Student's perception of mathematics teacher's attitude, interaction and dealings with student during mathematics class.

Parents' Help

Student's perception about parents' financial help for her/him and their educational involvement in the process of learning mathematics.

Parents' Expectation

Student's perception about parents' belief on the student's ability to learn mathematics and to excel in it.

Parents' Stereotypic beliefs

Student's perception about her/his parents' gender-biased thought and admiration of mathematics for males.

Interest in Mathematics as enjoyment (MIE)

Student's situational interest and stimulation during doing mathematics or solving mathematical problems.

Interest in Mathematics as Liking and Value (MIL)

Student's perception of value of mathematics in educational attainment and liking this discipline.

Interest in mathematics as annoying or agreeable (MIA)

Student's domain specific interest in mathematics based on psychological experiences in this discipline.

Mathematics Belief as Global Utility (MBU)

Student's belief about the importance and technological utility of mathematics for the development of the society.

Mathematics Belief as source of Intellectual development (MBI)

Student's belief about mathematics is necessary for intellectual development and appreciation of its utility in daily life.

Mathematics Belief for personal need (MBN)

Student's belief about mathematics as the better source of satisfying the self-recognition and financial needs.

APPENDIX-2

PRELIMINARY QUESTIONNAIRE

Dear Respondent,

I am a doctoral candidate and conducting a survey in the field of Mathematics Education. The purpose of this research is to figure out the problems of students concerning mathematics and reasons behind their avoidance of this discipline. For this purpose the following questionnaire is established to get related information. This questionnaire has two parts, first is consisted of two open end questions and the second one contains a checklist.

I assure you that the information you provide will be limited to the research study only and will be held in strict confidence. Therefore to assure this confidentiality, this questionnaire is kept anonymous.

Thank you in advance for your co-operation.

Nargis ABBAS

E-Mail: abbas@unistra.fr

Doctoral candidate,

University of Strasbourg. France.

PART 1

Your Age:___________ Year/semester:_________ Program (in which you study)______________

Your Institute's Name:__________________________ Your major subjects:_____________________

1- Write down the top ten reasons why did you opt/chose mathematics: (you can use extra sheet if you need.)

2- In your opinion what may be the reasons for not choosing/adopting mathematics by the students? Write down at least top five reasons: (you can use extra sheet if you need.)

PART 2

3- Among the following factors, what do you feel that which are the most important (enlist only 5 factors) in creating positive attitude of the students towards mathematics at school level (enter 1,2,3,4,5 to indicate them and put 1 for most important factor and so on):

Note: If you want add other factor than these enlisted ones, you can write in the end along with its rank.

- Self confidence ☐
- Self efficacy ☐
- Belief ☐
- Enjoying studying mathematics ☐
- Knowing importance of mathematics ☐
- Teacher’s behavior ☐
- Teacher’s methodology ☐
- Teacher’s expectation/motivation ☐
- Teacher’s knowledge ☐
- Parent’s motivation ☐
- Parent’s behavior ☐
- Parent’s help ☐
- Societal needs ☐

(Questionnaire for 9th Grade)

GENERAL INFORMATION

1. Your age : ____ 2- In which grade do you study? _________

3-Gender : ☐Female ☐Male 4- Your school name:______________________

5- Your father's qualification (Encircle the right option)

i. Doesn't know how to read and write
ii. Primary school
iii. High school (Matric/ Intermediate)
iv. Graduation and higher

6- Your mother's qualification (Encircle the right option)

i. Don't know read and write
ii. Primary school
iii. High school (Matric/ Intermediate)
iv. Graduation and higher

7- Does your mother do the job outside home? ☐Yes ☐No.

8- What does your father do? ____

9- How many?

Your brothers ☐ Your sisters ☐ Your number in family ☐

10- Does any of your family member, relative or friends have occupation that involves mathematics or computer? ☐ Yes ☐ No

11- Who are they?

Relationship to you	Occupation	Qualification	Helps you in Maths?(Yes/No)
______________	__________	_________	________
______________	__________	_________	________
______________	__________	_________	________
______________	__________	_________	________
______________	__________	_________	________

12- Do you take private coaching after school? ☐ Yes ☐ No

13- For which subject do you think tuition is necessary? ____________________________

QUESTIONNAIRE (PART 1)

Instructions: *In front of each statement, five possible answers are given in the columns. Read carefully each statement and tick (✓) the option that is most appropriate answer according to your point of view.*

KEY:

SD= Strongly Disagreed **D**= Disagreed **U**= Undecided

A= Agreed **SA**= Strongly Agreed

Sr.No	Statements	SD	D	U	A	SA
1	Mathematics is the most important subject among all subjects in school.					
2	I can solve Mathematical problem without seeking the help of others.					
3	I like mathematics because we can get good marks in it.					
4	My mathematics teacher encourages me to ask question and to learn mathematics.					
5	We need to do better in mathematics if we want to be praised.					
6	If I need, my parents arrange private coaching of Mathematics for me.					
7	Careers including Mathematics are suitable for boys.					
8	I'm always keen to learn the next coming concept before the teacher would deliver it in the class.					
9	There is no technology without mathematics.					
10	My Mathematics teacher doesn't have same attitude towards all students.					
11	I feel hesitation and fear of asking questions to my mathematics teacher during the lecture.					
12	No matter how hard I try, I cannot understand mathematics.					

Sr.No	Statements	SD	D	U	A	SA
13	I can freely discuss the problems of mathematics with my parents.					
14	I fail in mathematics because of poor teaching of the teacher.					
15	I get motivate towards learning of mathematics when I successfully solve the question.					
16	Mathematics is difficult to understand.					
17	Girls do better than boys in mathematics.					
18	My mathematics teacher likes only bright students in the class.					
19	Mathematics is just to get a correct answer of the question.					
20	My parents expect that their sons should be good in mathematics.					
21	School mathematics has no relevance with real life.					
22	My Mathematics teacher teaches in a very friendly environment					
23	Mathematics should not be compulsory subject in school.					
24	My teacher helps me when I don’t understand mathematics.					

Identity No :

Questionnaire (PART 2)

Instructions: *In front of each statement, five possible answers are given in the columns. Read carefully each statement and tick (✓) the option that is most appropriate answer according to your point of view.*

KEY:

SD= Strongly Disagreed **D**= Disagreed **U**= Undecided

A= Agreed **SA**= Strongly Agreed

Sr.No	Statements	SD	D	U	A	SA
25	I cannot do well in mathematics					
26	Mathematics is important for the development of the country.					
27	I never found a good teacher of mathematics.					
28	Mathematics is dull and boring because we can't explain the things in our own words.					
29	My Mathematics teacher punishes without knowing the reason when I don't do homework.					
30	My Mathematics teacher explains the concepts in detail by giving examples.					
31	Mathematics makes me tense and uncomfortable.					
32	I feel that my mathematics teacher ignores me when I try to ask question in the class.					
33	My mathematics teacher makes me feel that I've the ability to do mathematics well.					
34	Mathematics problem is like a game to me which I want to play and win.					
35	We can spend a good life without using mathematics in our daily life.					
36	I am sure that I can easily qualify mathematics test.					
37	My teacher thinks that I can have a good career in science and mathematics.					
38	My teacher starts directly solving the exercise questions without explaining the real concept.					

Sr.No	Statement	SD	D	U	A	SA
39	I'm not good in mathematics as compare to other students in the class.					
40	My parents think that mathematics is for males not for females.					
41	I enjoy studying mathematics in class.					
42	My teacher says that mathematics is difficult subject and I can't do it.					
43	Mathematics helps in developing a person's mind and teaches him how to think.					
44	My mathematics teacher has a good knowledge of mathematics.					
45	My parents help me in doing mathematics.					
46	I dislike mathematics even if I get good marks in mathematics.					
47	My success in mathematics is due to my teacher's help.					
48	I heard my parents saying that they were also not good in mathematics.					
49	It's hard to get the mathematics teacher to respect me.					
50	Mathematics is the most difficult subject for me.					
51	My teacher is interested in my mathematics progress.					
52	My parents make me feel that mathematics is hard and dry subject and I'm weak.					
53	I don't like mathematics because of my mathematics teacher.					
54	My parents discourage me if I inquire about the things.					
55	With mathematics we can get scholarships or part-time job easily to cover our educational expenses.					
56	My Mathematics teacher doesn't allow dull students to sit in the front row of the classroom.					
57	Female teachers teach mathematics more poorly than do male teachers.					

Questionnaire For 6th Grade

GENERAL INFORMATION

2. Your age : ____ 2- In which grade do you study? _________

3-Gender : ☐Female ☐Male 4- Your school name:_______________________

5- Your father's qualification (Encircle the right option)

i. Doesn't know how to read and write
ii. Primary school
iii. High school (Matric/ Intermediate)
iv. Graduation and higher

6- Your mother's qualification (Encircle the right option)

i. Don't know read and write
ii. Primary school
iii. High school (Matric/ Intermediate)
iv. Graduation and higher

7- Does your mother do the job outside home? ☐Yes ☐No.

8- What does your father do? ____

9- How many?

Your brothers ☐ Your sisters ☐ Your number in family ☐

10- Does any of your family member, relative or friends have occupation that involves mathematics or computer? ☐ Yes ☐ No

11- Who are they?

Relationship to you	Occupation	Qualification	Helps you in Maths?(Yes/No)
________________	____________	___________	__________
________________	____________	___________	__________
________________	____________	___________	__________
________________	____________	___________	__________
________________	____________	___________	__________

12- Do you take private coaching after school? ☐ Yes ☐ No

13- For which subject do you think tuition is necessary? ________________________________

QUESTIONNAIRE (PART 1)

Instructions: *In front of each statement there are given five possible answers in the columns. Read carefully each statement and tick (✓) the option that is most appropriate answer according to your point of view.*

KEY:

SD= Strongly Disagreed **D**= Disagreed **U**= Undecided

A= Agreed **SA**= Strongly Agreed

Sr. No.	Statements	SD	D	U	A	SA
1	Mathematics is the most important subject among all subjects in school.					
2	I can solve Mathematical problem without seeking the help of others.					
3	I like mathematics because we can get good marks in it.					
4	My mathematics teacher encourages me to ask question and to learn mathematics.					
5	We need to do better in mathematics if we want to become famous.					
6	If I need, my parents arrange private coaching of mathematics for me.					
7	Careers including mathematics are suitable for boys.					
8	I'm always keen to learn the next coming concept before the teacher would deliver it in the class.					
9	There is no technology without mathematics.					
10	My Mathematics teacher doesn't have same attitude towards all students.					
11	I feel hesitation and fear of asking questions to my mathematics teacher during the lecture.					
12	No matter how hard I try, I cannot understand mathematics.					
13	I can freely discuss the problems of mathematics with my parents.					

Sr. No.	Statements	SD	D	U	A	SA
14	I fail in mathematics because of poor teaching of the teacher.					
15	I get motivate towards learning of mathematics when I successfully solve the question.					
16	Mathematics is difficult to understand.					
17	Girls do better than boys in mathematics.					
18	My mathematics teacher likes only bright students in the class.					
19	Mathematics is just to get a correct answer of the question.					
20	My parents expect that their sons should be good in mathematics.					
21	I don’t see the use of mathematics concepts around me which I study in mathematics book.					
22	My mathematics teacher teaches in a very friendly environment.					
23	Mathematics should not be compulsory subject in school.					
24	My teacher helps me when I don’t understand mathematics.					

Identity No :

Questionnaire (PART 2)

Instructions: *In front of each statement there are given five possible answers in the columns. Read carefully each statement and tick (✓) the option that is most appropriate answer according to your point of view.*

KEY:

SD= Strongly Disagreed **D**= Disagreed **U**= Undecided

A= Agreed **SA**= Strongly Agreed

Sr.No.	Statements	SD	D	U	A	SA
25	I cannot do well in Mathematics.					
26	Mathematics is important for the development of the country.					
27	I never found a good teacher of mathematics.					
28	Mathematics is dull and boring because we can't explain the things in our own words.					
29	My Mathematics teacher punishes without knowing the reason when I don't do homework.					
30	My Mathematics teacher explains the concepts in detail by giving examples.					
31	Mathematics makes me tense and uncomfortable.					
32	I feel that my mathematics teacher ignores me when I try to ask question in the class.					
33	My mathematics teacher makes me feel that I've the ability to do mathematics well.					
34	Mathematics problem is like a game to me which I want to play and win.					
35	We can spend a good life without using mathematics in our daily life.					
36	I am sure that I can easily qualify mathematics test.					
37	My teacher thinks that I can have a good career in science and mathematics.					
38	My teacher starts directly solving the exercise questions without explaining the real concept.					

Sr. No.	Statements	SD	D	U	A	SA
39	I'm not good in mathematics as compare to other students in the class.					
40	My parents think that mathematics is for males not for females.					
41	To do mathematics is fun for me.					
42	My teacher says that mathematics is difficult subject and I can't do it.					
43	Mathematics helps in developing a person's mind and teaches him how to think.					
44	My mathematics teacher has a good knowledge of mathematics.					
45	My parents help me in doing mathematics.					
46	I dislike mathematics even if I get good marks in mathematics.					
47	My success in mathematics is due to my teacher's help.					
48	I heard my parents saying that they were also not good in mathematics.					
49	It's hard to get the mathematics teacher to respect me.					
50	Mathematics is the most difficult subject for me.					
51	My teacher is interested in my mathematics progress.					
52	My parents make me feel that mathematics is a hard and dry subject and I'm weak.					
53	I don't like mathematics because of my mathematics teacher.					
54	My parents discourage me if I inquire about the things.					
55	One must be good in mathematics to get scholarship.					
56	My Mathematics teacher doesn't allow dull students to sit in the front row of the classroom.					
57	Female teachers teach mathematics more poorly than do male teachers.					

Appendix 2C (6th Grade)

P-6 (6th Grade_Girls)

	انتہائی متفق	متفق	معلوم نہیں	غیر متفق	انتہائی غیر متفق
51۔میری اُستانی صاحبہ ریاضی میں میری کارکردگی میں دلچسپی لیتی ہیں۔					
52۔ میرے والدین مجھے یہ احساس دلاتے ہیں کہ ریاضی ایک مشکل اور خشک مضمون ہے اور میں کمزور ہوں۔					
53- مجھے ریاضی اپنی ریاضی کی اُستانی صاحبہ کی وجہ سے اچھا نہیں لگتا۔					
54- میرے والدین میری حوصلہ شکنی کرتے ہیں اگر میں ان سے چیزوں کی وجوہات پوچھوں یا سوال کروں۔					
55- وظیفہ حاصل کرنے کے لئے ریاضی میں اچھا ہونا ضروری ہے۔					
56- ریاضی کی اُستانی صاحبہ کم ذہین طالبات کو جماعت میں آگے بیٹھنے نہیں دیتیں۔					
57- خواتین اساتذہ کا ریاضی کا طریقہ تدریس مرد اساتذہ کی نسبت غیر معیاری ہوتا ہے۔					

	انتہائی متفق	متفق	معلوم نہیں	غیر متفق	انتہائی غیر متفق
37- میری ریاضی کی اُستانی صاحبہ کا خیال ہے کہ میں ریاضی اور سائنس سے منسلک شعبہ میں ترقی کرسکتی ہوں۔					
38- میری ریاضی کی اُستانی صاحبہ مشق سے پہلے دیا گیا موادنہیں سمجھاتی بلکہ سیدھا مشق کے سوال سمجھانا اورحل کرنا شروع کردیتی ہیں					
39- میں جماعت میں موجود دوسرے بچوں کی نسبت ریاضی میں اچھی نہیں ہوں۔					
40- میرے والدین کا خیال ہے کہ ریاضی صرف لڑکوں کے لئے ضروری ہے لڑکیوں کے لئے نہیں۔					
41- ریاضی کے سوال حل کرنا میرے لئے تفریح ہے۔					
42۔میری ریاضی کی اُستانی صاحبہ کہتی ہیں کہ ریاضی مشکل ہے اور میں اسے نہیں پڑھ سکتی۔					
43۔ ریاضی انسان کے دماغ کی نشو ونما میں مدد کرتا ہے اور سوچنا سکھاتا ہے۔					
44۔میری اُستانی صاحبہ کے پاس ریاضی کا بہت علم ہے۔					
45- میرے والدین ریاضی کے سوال حل کرنے میں میری مدد کرتے ہیں۔					
46۔میرے ریاضی میں اچھے نمبر بھی آجائیں تو بھی مجھے ریاضی پسند نہیں۔					
47- میں ریاضی میں اپنی استانی صاحبہ کی مدد کی وجہ سے کامیاب ہوتی ہوں۔					
48۔میں نے اپنے والدین کو اکثر یہ کہتے ہوئے سُنا ہے کہ وہ بھی ریاضی میں کمزور تھے۔					
49۔ یہ بہت مشکل ہے کہ ریاضی کی اُستانی صاحبہ میری تعریف کریں۔					
50۔ریاضی میرے لئے سب سے زیادہ مشکل مضمون ہے۔					

سوالنامہ (حصہ دوم)

ہدایات: نیچے دیئے گئے ہر بیان کے سامنے 5 ممکنہ جوابات کے لیئے کالم دیئے گئے ہیں۔ ہر بیان کوغور سے پڑھئے اوران 5 ممکنہ جوابات میں سے جو آپ کے نزدیک بہترین جواب ہے اُس خانے میں ✓ کا نشان لگا دیں۔

	انتہائی متفق	متفق	معلوم ہیں	غیر متفق	انتہائی غیر متفق
25- میں ریاضی میں بہتر کارکردگی کا مظاہرہ نہیں کرسکتی۔					
26- ملک کی ترقی کے لئے ریاضی کا مضمون پڑھنا بہت ضروری ہے۔					
27- مجھے کبھی بھی ریاضی کا اچھا استاد یا اُستانی صاحبہ نہیں ملی۔					
28- ریاضی غیر دلچسپ اور اُکتا دینے والا مضمون ہے۔کیونکہ ہم کوئی چیز اپنے الفاظ میں بیان نہیں کر سکتے۔					
29- اگر میں کسی دن ریاضی کا ہوم ورک نہ کرسکوں تو میری اُستانی صاحبہ وجہ جانے یا مانے بغیر مجھے سزا دے دیتی ہیں۔					
30- میری ریاضی کی اُستانی صاحبہ ریاضی کے تصورات بہت تفصیل کے ساتھ مثالوں سے سمجھاتی ہیں۔					
31۔ میں ریاضی کی وجہ سے پریشان اور بے چین ہو جاتی ہوں۔					
32۔ مجھے ایسا لگتا ہے کہ جب کبھی میں کلاس میں سوال پوچھتی ہوں تو میری ریاضی کی اُستانی صاحبہ مجھے نظر انداز کرتی ہیں۔					
33۔ میری ریاضی کی اُستانی صاحبہ مجھے احساس دلاتی ہیں کہ میں ریاضی میں اور اچھا کام کرنے کی صلاحیت رکھتی ہوں۔					
34- ریاضی کے سوال میرے لئے ایک کھیل کی طرح ہوتے ہیں جنھیں میں کھیلنا اور جیتنا چاہتی ہوں۔					
35- ہم ریاضی کو روزمرہ زندگی میں استعمال کئے بغیر بھی اچھی زندگی گزار سکتے ہیں۔					
36- مجھے اعتماد ہے کہ میں بآسانی ریاضی میں کامیاب ہوسکتی ہوں۔					

P-3 (6th Grade_Girls)

انتہائی غیر متفق	غیر متفق	معلوم نہیں	متفق	انتہائی متفق	
					12- میں چاہے جتنی بھی کوشش کرلوں ریاضی سمجھ نہیں سکتی۔
					13- میں اپنے والدین سے بلا جھجک ریاضی میں درپیش اپنے مسائل کے بارے میں بات کرلیتی ہوں۔
					14- ریاضی کی اُستانی صاحبہ کی غیر معیاری تدریس کی وجہ سے میں ریاضی میں فیل ہوتی ہوں۔
					15- میں ریاضی کو سیکھنے کے لئے پُر جوش ہوجاتی ہوں جب میں سوال کو ٹھیک حل کرلیتی ہوں۔
					16- ریاضی کو سمجھنا بہت مشکل ہے۔
					17- ریاضی میں لڑکیوں کی کارکردگی لڑکوں کی نسبت اچھی ہوتی ہے۔
					18- میری ریاضی کی اُستانی صاحبہ صرف ذہین طالبات کو پسند کرتی ہیں۔
					19- ریاضی میں صرف سوال کا درست جواب آنا چاہئے اور اس میں کچھ نہیں۔
					20- میرے والدین چاہتے ہیں کہ ان کے بیٹوں/لڑکوں کو ریاضی میں اچھا ہونا چاہیے۔
					21- مجھے ریاضی کی کتاب میں پڑھنے والی چیزوں کا استعمال اپنے اردگرد نظر نہیں آتا۔
					22- میری ریاضی کی اُستانی صاحبہ ہمیں بڑے دوستانہ ماحول میں پڑھاتی ہیں۔
					23- اسکول میں ریاضی کو لازمی مضمون نہیں ہونا چاہئے۔
					24- اگر مجھے کوئی سوال سمجھ نہ آئے تو میری ریاضی کی اُستانی صاحبہ میری مدد کرتی ہیں۔

سوالنامہ (حصہ اول)

ہدایات:

نیچے دیئے گئے ہر بیان کے سامنے 5 ممکنہ جوابات کے لیئے کالم دیئے گئے ہیں۔ ہر بیان کوغور سے پڑھئے اور ان 5 ممکنہ جوابات میں سے جو آپ کے نزدیک بہترین جواب ہے اُس خانے میں ✓ کا نشان لگادیں۔

	انتہائی متفق	متفق	معلوم نہیں	غیر متفق	انتہائی غیر متفق
1- ریاضی تمام مضامین میں سب سے زیادہ اہم ہے۔					
2- میں کسی کی مدد کے بغیر سوال کو خود حل کرنے کی کوشش کرتی ہوں۔					
3- مجھے ریاضی کا مضمون پسند ہے کیونکہ اس میں نمبر اچھے آتے ہیں۔					
4- میری ریاضی کی اُستانی صاحبہ مجھے سوال پوچھنے اور ریاضی سیکھنے میں میری حوصلہ افزائی کرتی ہیں۔					
5- اگر ہم اپنی تعریف کروانا چاہتے ہیں تو ہمیں ریاضی میں بہت اچھے نمبر حاصل کرنا ہوں گے۔					
6- اگر مجھے ضرورت ہو تو میرے والدین میرے لئے ریاضی کی ٹیوشن کا انتظام کرتے ہیں۔					
7- ریاضی سے منسلک شعبے صرف لڑکوں کے لئے موزوں ہیں۔					
8- میں ریاضی کا نیا سبق پہلے ہی سے تیار کرنا چاہتی ہوں جو میری اُستانی صاحبہ نے اگلے دن جماعت میں پڑھانا ہوتا ہے۔					
9- ریاضی کے بغیر کسی ٹیکنالوجی کا وجود نہیں۔					
10- میری ریاضی کی اُستانی صاحبہ کا تمام طالبات کے ساتھ ایک جیسا رویہ نہیں ہے۔					
11- میں اپنی ہچکچاہٹ کی وجہ سے جماعت میں اُستانی صاحبہ سے دورانِ سبق کچھ نہیں پوچھتی۔					

شناختی نمبر۔

عمومی معلومات

۱۔آپ کی عمر۔---------- ۲۔آپ کس جماعت میں پڑھتی ہیں۔--------- ۳۔آپ کے سکول کا نام۔-----------------

۵۔ آپ کے والد صاحب کی تعلیم (درج ذیل میں سے کسی ایک پر × لگائیں)

(ا)۔لکھنا پڑھنا نہیں جانتے۔ ☐

(ب)۔پرائمری تعلیم ☐

(ج)۔ہائی سکول میٹرک/انٹرمیڈیٹ ☐

(د)۔اعلیٰ تعلیم ☐

۶۔ آپ کے والد صاحب کیا ملازمت کرتے ہیں؟

۷۔ آپ کی والدہ صاحبہ کی تعلیم (درج ذیل میں سے کسی ایک پر × لگائیں)

(ا)۔لکھنا پڑھنا نہیں جانتیں۔ ☐

(ب)۔پرائمری تعلیم ☐

(ج)۔ہائی سکول میٹرک/انٹرمیڈیٹ ☐

(د)۔اعلیٰ تعلیم ☐

۸۔کیا آپ کی والدہ صاحبہ ملازمت کرتی ہیں؟ ہاں ☐ نہیں ☐

۹۔ کتنے ہیں؟ آپ کے بھائی --------- آپ کی بہنیں---------- بہن بھائیوں میں آپ کا نمبر---------

۱۰۔کیا آپ کے خاندان، رشتے دار یا دوستوں میں سے کسی کا پیشہ ریاضی یا کمپیوٹر سے منسلک ہے؟ ہاں ☐ نہیں ☐

۱۱۔وہ کون ہیں؟

آپ سے رشتہ	پیشہ	تعلیم	آپ کی ریاضی میں مدد کرتے ہیں؟ (ہاں / نہیں)
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۱۲۔کیا آپ سکول کے بعد ٹیوشن پڑھتی ہیں؟ ہاں ☐ نہیں ☐

۱۳۔آپ کے خیال میں کس مضمون کی ٹیوشن پڑھنا سب سے ضروری ہے؟ -----------------

P-6 (6th Grade_Boys)

	انتہائی متفق	متفق	معلوم نہیں	غیر متفق	انتہائی غیر متفق
51۔ میرے اُستاد صاحب ریاضی میں میری کارکردگی میں دلچسپی لیتے ہیں۔					
52۔ میرے والدین مجھے یہ احساس دلاتے ہیں کہ ریاضی ایک مشکل اور خشک مضمون ہے اور میں کمزور رہوں۔					
53- مجھے ریاضی اپنی ریاضی کے اُستاد صاحب کی وجہ سے اچھا نہیں لگتا۔					
54- میرے والدین میری حوصلہ شکنی کرتے ہیں اگر میں ان سے چیزوں کی وجوہات پوچھوں یا سوال کروں۔					
55- وظیفہ حاصل کرنے کے لئے ریاضی میں اچھا ہونا ضروری ہے۔					
56- ریاضی کے اُستاد صاحب کم ذہین طلباء کو جماعت میں آگے بیٹھنے نہیں دیتے۔					
57- خواتین اساتذہ کا ریاضی کا طریقہ تدریس مرد اساتذہ کی نسبت غیر معیاری ہوتا ہے۔					

P-5 (6th grade_Boys)

	انتہائی متفق	متفق	معلوم نہیں	غیر متفق	انتہائی غیر متفق
37- میرے ریاضی کے اُستاد صاحب کا خیال ہے کہ میں ریاضی اور سائنس سے منسلک شعبہ میں ترقی کرسکتا ہوں۔					
38- میرے ریاضی کے اُستاد صاحب مشق سے پہلے دیا گیا مواد نہیں سمجھاتے بلکہ سیدھا مشق کے سوال سمجھانا اور حل کرنا شروع کردیتے ہیں					
39- میں جماعت میں موجود دوسرے بچوں کی نسبت ریاضی میں اچھا نہیں ہوں۔					
40- میرے والدین کا خیال ہے کہ ریاضی صرف لڑکوں کے لئے ضروری ہے لڑکیوں کے لئے نہیں۔					
41- ریاضی کے سوال حل کرنا میرے لئے تفریح ہے۔					
42- میرے ریاضی کے اُستاد صاحب کہتے ہیں کہ ریاضی مشکل ہے اور میں اسے نہیں پڑھ سکتا۔					
43- ریاضی انسان کے دماغ کی نشو ونما میں مدد کرتا ہے اور سوچنا سکھاتا ہے۔					
44- میرے اُستاد صاحب کے پاس ریاضی کا بہت علم ہے۔					
45- میرے والدین ریاضی کے سوال حل کرنے میں میری مدد کرتے ہیں۔					
46- میرے ریاضی میں اچھے نمبر بھی آجائیں تو بھی مجھے ریاضی پسند نہیں۔					
47- میں ریاضی میں اپنی استاد صاحب کی مدد کی وجہ سے کامیاب ہوتا ہوں۔					
48- میں نے اپنے والدین کو اکثر یہ کہتے ہوئے سُنا ہے کہ وہ بھی ریاضی میں کمزور تھے۔					
49- یہ بہت مشکل ہے کہ ریاضی کی اُستاد صاحب میری تعریف کریں۔					
50- ریاضی میرے لئے سب سے زیادہ مشکل مضمون ہے۔					

سوالنامہ (حصہ دوم)

ہدایات: نیچے دیئے گئے ہر بیان کے سامنے 5 ممکنہ جوابات کے لیئے کالم دیئے گئے ہیں۔ ہر بیان کو غور سے پڑھئے اور ان 5 ممکنہ جوابات میں سے جو آپ کے نزدیک بہترین جواب ہے اُس خانے میں ✓ کا نشان لگا دیں۔

	انتہائی متفق	متفق	معلوم نہیں	غیر متفق	انتہائی غیر متفق
25- میں ریاضی میں بہتر کارکردگی کا مظاہرہ نہیں کر سکتا۔					
26- ملک کی ترقی کے لئے ریاضی کا مضمون پڑھنا بہت ضروری ہے۔					
27- مجھے کبھی بھی ریاضی کا اچھا استاد یا اُستانی صاحبہ نہیں ملی۔					
28- ریاضی غیر دلچسپ اور اُکتا دینے والا مضمون ہے۔ کیونکہ ہم کوئی چیز اپنے الفاظ میں بیان نہیں کر سکتے۔					
29- اگر میں کسی دن ریاضی کا ہوم ورک نہ کر سکوں تو میرے ریاضی کے اُستاد صاحب وجہ جانے یا مانے بغیر مجھے سزا دیتے ہیں۔					
30- میرے ریاضی کے اُستاد صاحب ریاضی کے تصورات بہت تفصیل کے ساتھ مثالوں سے سمجھاتے ہیں۔					
31۔ میں ریاضی کی وجہ سے پریشان اور بے چین ہو جاتا ہوں۔					
32۔ مجھے ایسا لگتا ہے کہ جب کبھی میں کلاس میں سوال پوچھتا ہوں تو میرے ریاضی کے اُستاد صاحب مجھے نظر انداز کرتے ہیں۔					
33۔ میرے ریاضی کے اُستاد صاحب مجھے احساس دلاتے ہیں کہ میں ریاضی میں اور اچھا کام کرنے کی صلاحیت رکھتا ہوں۔					
34- ریاضی کے سوال میرے لئے ایک کھیل کی طرح ہوتے ہیں جنھیں میں کھیلنا اور جیتنا چاہتا ہوں۔					
35- ہم ریاضی کو روزمرہ زندگی میں استعمال کئے بغیر بھی اچھی زندگی گزار سکتے ہیں۔					
36- مجھے اعتماد ہے کہ میں بآسانی ریاضی میں کامیاب ہو سکتا ہوں۔					

P-3 (6th Grade_Boys)

انتہائی غیر متفق	غیر متفق	معلوم نہیں	متفق	انتہائی متفق	
					12- میں چاہے جتنی بھی کوشش کرلوں ریاضی سمجھ نہیں سکتا۔
					13- میں اپنے والدین سے بلا جھجک ریاضی میں درپیش اپنے مسائل کے بارے میں بات کر لیتا ہوں۔
					14- ریاضی کے اُستاد صاحب کی غیر معیاری تدریس کی وجہ سے میں ریاضی میں فیل ہوتا ہوں۔
					15- میں ریاضی کو سیکھنے کے لئے پُر جوش ہو جاتا ہوں جب میں سوال کو ٹھیک حل کر لیتا ہوں۔
					16- ریاضی کو سمجھنا بہت مشکل ہے۔
					17- ریاضی میں لڑکیوں کی کارکردگی لڑکوں کی نسبت اچھی ہوتی ہے۔
					18- میرے ریاضی کے اُستاد صاحب صرف ذہین طلباً کو پسند کرتے ہیں۔
					19- ریاضی میں صرف سوال کا درست جواب آنا چاہئے اور اس میں کچھ نہیں۔
					20- میرے والدین چاہتے ہیں کہ ان کے بیٹوں/لڑکوں کو ریاضی میں اچھا ہونا چاہیے۔
					21- مجھے ریاضی کی کتاب میں پڑھنے والی چیزوں کا استعمال اپنے اردگرد نظر نہیں آتا۔
					22- میرے ریاضی کے اُستاد صاحب ہمیں بڑے دوستانہ ماحول میں پڑھاتے ہیں۔
					23- اسکول میں ریاضی کو لازمی مضمون نہیں ہونا چاہئے۔
					24- اگر مجھے کوئی سوال سمجھ نہ آئے تو میرے ریاضی کے اُستاد صاحب میری مدد کرتے ہیں۔

سوالنامہ (حصہ اول)

ہدایات:

نیچے دیئے گئے ہر بیان کے سامنے 5 ممکنہ جوابات کے لیئے کالم دیئے گئے ہیں۔ ہر بیان کو غور سے پڑھئے اور ان 5 ممکنہ جوابات میں سے جو آپ کے نزدیک بہترین جواب ہے اُس خانے میں ✓ کا نشان لگا دیں۔

	انتہائی متفق	متفق	معلوم نہیں	غیر متفق	انتہائی غیر متفق
1- ریاضی تمام مضامین میں سب سے زیادہ اہم ہے۔					
2- میں کسی کی مدد کے بغیر سوال کو خود حل کرنے کی کوشش کرتا ہوں۔					
3- مجھے ریاضی کا مضمون پسند ہے کیونکہ اس میں نمبر اچھے آتے ہیں۔					
4- میرے ریاضی کے اُستاد صاحب مجھے سوال پوچھنے اور ریاضی سیکھنے میں میری حوصلہ افزائی کرتے ہیں۔					
5- اگر ہم اپنی تعریف کروانا چاہتے ہیں تو ہمیں ریاضی میں بہت اچھے نمبر حاصل کرنا ہوں گے۔					
6- اگر مجھے ضرورت ہو تو میرے والدین میرے لئے ریاضی کی ٹیوشن کا انتظام کرتے ہیں۔					
7- ریاضی سے منسلک شعبے صرف لڑکوں کے لئے موزوں ہیں۔					
8- میں ریاضی کا نیا سبق پہلے ہی سے تیار کرنا چاہتا ہوں جو میرے اُستاد صاحب نے اگلے دن جماعت میں پڑھانا ہوتا ہے۔					
9- ریاضی کے بغیر کسی ٹیکنالوجی کا وجود نہیں۔					
10- میرے ریاضی کے اُستاد صاحب کا تمام طلباً کے ساتھ ایک جیسا رویہ نہیں ہے۔					
11- میں اپنی ہچکچاہٹ کی وجہ سے جماعت میں اُستاد صاحب سے دورانِ سبق کچھ نہیں پوچھتا۔					

شناختی نمبر۔

عمومی معلومات

۱۔آپ کی عمر۔۔۔۔۔۔۔۔۔۔ ۲۔آپ کس جماعت میں پڑھتے ہیں۔۔۔۔۔۔۔۔۔ ۳۔آپ کے سکول کا نام۔۔۔۔۔۔۔۔۔۔۔۔۔۔۔۔

۵۔ آپ کے والد صاحب کی تعلیم (درج ذیل میں سے کسی ایک پر × لگائیں)

(ا)۔لکھنا پڑھنا نہیں جانتے۔ ☐

(ب)۔پرائمری تعلیم ☐

(ج)۔ہائی سکول میٹرک/انٹرمیڈیٹ ☐

(د)۔اعلیٰ تعلیم ☐

۶۔ آپ کے والد صاحب کیا ملازمت کرتے ہیں؟

۷۔ آپ کی والدہ صاحبہ کی تعلیم (درج زیل میں سے کسی ایک پر × لگائیں)

(ا)۔لکھنا پڑھنا نہیں جانتیں۔ ☐

(ب)۔پرائمری تعلیم ☐

(ج)۔ہائی سکول میٹرک/انٹرمیڈیٹ ☐

(د)۔اعلیٰ تعلیم ☐

۸۔کیا آپ کی والدہ صاحبہ ملازمت کرتی ہیں؟ ہاں ☐ نہیں ☐

۹۔ کتنے ہیں؟ آپ کے بھائی ۔۔۔۔۔۔۔۔۔ آپ کی بہنیں۔۔۔۔۔۔۔۔۔۔ بہن بھائیوں میں آپ کا نمبر۔۔۔۔۔۔۔۔

۱۰۔کیا آپ کے خاندان، رشتے دار یا دوستوں میں سے کسی کا پیشہ ریاضی یا کمپیوٹر سے منسلک ہے؟ ہاں ☐ نہیں ☐

۱۱۔وہ کون ہیں؟

آپ سے رشتہ	پیشہ	تعلیم	آپ کی ریاضی میں مدد کرتے ہیں؟(ہاں / نہیں)
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۱۲۔کیا آپ سکول کے بعد ٹیوشن پڑھتے ہیں؟ ہاں ☐ نہیں ☐

۱۳۔آپ کے خیال میں کس مضمون کی ٹیوشن پڑھنا سب سے ضروری ہے؟ -----------------

P-6 (9th grade_Girls)

	انتہائی متفق	متفق	معلوم نہیں	غیر متفق	انتہائی غیر متفق
50۔ ریاضی میرے لئے سب سے زیادہ مشکل مضمون ہے۔					
51۔ میری اُستانی صاحبہ ریاضی میں میری کارکردگی میں دلچسپی لیتی ہیں۔					
52- میرے والدین مجھے یہ احساس دلاتے ہیں کہ ریاضی ایک مشکل اور خشک مضمون ہے اور میں کمزور ہوں۔					
53- مجھے ریاضی اپنی ریاضی کی اُستانی صاحبہ کی وجہ سے اچھا نہیں لگتا۔					
54- میرے والدین میری حوصلہ شکنی کرتے ہیں اگر میں ان سے چیزوں کی وجوہات پوچھوں یا سوال کروں۔					
55- اگر ہمیں ریاضی آتا ہو تو ہم با آسانی وظیفہ حاصل کر سکتے ہیں یا تعلیمی اخراجات کو پورا کرنے کیلئے عارضی ملازمت حاصل کر سکتے ہیں۔					
56- ریاضی کی اُستانی صاحبہ کم ذہین طالبات کو جماعت میں آگے بیٹھنے نہیں دیتیں۔					
57- خواتین اساتذہ کا ریاضی کا طریقہ تدریس مرد اساتذہ کی نسبت غیر معیاری ہوتا ہے۔					

P-5 (9th grade_Girls)

	انتہائی متفق	متفق	معلوم نہیں	غیر متفق	انتہائی غیر متفق
37- میری ریاضی کی اُستانی صاحبہ کا خیال ہے کہ میں ریاضی اور سائنس سے منسلک شعبہ میں ترقی کرسکتی ہوں۔					
38- میری ریاضی کی اُستانی صاحبہ مشق سے پہلے دیا گیا مواد نہیں سمجھاتی بلکہ سیدھا مشق کے سوال سمجھانا اور حل کرنا شروع کردیتی ہیں۔					
39- میں جماعت میں موجود دوسرے بچوں کی نسبت ریاضی میں اچھی نہیں ہوں۔					
40- میرے والدین کا خیال ہے کہ ریاضی صرف لڑکوں کے لئے ضروری ہے لڑکیوں کے لئے نہیں۔					
41-میں جماعت میں ریاضی کے مطالعے سے لطف اندوز ہوتی ہوں۔					
42- میری ریاضی کی اُستانی صاحبہ کہتی ہیں کہ ریاضی مشکل ہے اور میں اسے نہیں پڑھ سکتی۔					
43- ریاضی انسان کے دماغ کی نشو ونما میں مدد کرتا ہے اور سوچنا سکھاتا ہے۔					
44-میری اُستانی صاحبہ کے پاس ریاضی کا بہت علم ہے۔					
45- میرے والدین ریاضی کے سوال حل کرنے میں میری مدد کرتے ہیں۔					
46-میرے ریاضی میں اچھے نمبر بھی آجائیں تو بھی مجھے ریاضی پسند نہیں۔					
47-میں ریاضی میں اپنی استانی صاحبہ کی مدد کی وجہ سے کامیاب ہوتی ہوں۔					
48-میں نے اپنے والدین کو اکثر یہ کہتے ہوئے سُنا ہے کہ وہ بھی ریاضی میں کمزور تھے۔					
49- یہ بہت مشکل ہے کہ ریاضی کی اُستانی صاحبہ میری تعریف کریں۔					

شناختی نمبر۔

سوالنامہ (حصہ دوم)

ہدایات: نیچے دیئے گئے ہر بیان کے سامنے 5 ممکنہ جوابات کے لیئے کالم دیئے گئے ہیں۔ ہر بیان کو غور سے پڑھیئے اور ان 5 ممکنہ جوابات میں سے جو آپ کے نزدیک بہترین جواب ہے اُس خانے میں ✓ کا نشان لگا دیں۔

	انتہائی متفق	متفق	معلوم نہیں	غیر متفق	انتہائی غیر متفق
25- میں ریاضی میں بہتر کارکردگی کا مظاہرہ نہیں کر سکتی۔					
26- ملک کی ترقی کے لئے ریاضی کا مضمون پڑھنا بہت ضروری ہے۔					
27- مجھے کبھی بھی ریاضی کا اچھا استاد یا اُستانی صاحبہ نہیں ملی۔					
28- ریاضی غیر دلچسپ اور اُکتا دینے والا مضمون ہے کیونکہ ہم کوئی چیز اپنے الفاظ میں بیان نہیں کر سکتے۔					
29- اگر میں کسی دن ریاضی کا ہوم ورک نہ کر سکوں تو میری اُستانی صاحبہ وجہ جانے یا مانے بغیر مجھے سزا دے دیتی ہیں۔					
30- میری ریاضی کی اُستانی صاحبہ ریاضی کے تصورات بہت تفصیل کے ساتھ مثالوں سے سمجھاتی ہیں۔					
31۔ میں ریاضی کی وجہ سے پریشان اور بے چین ہو جاتی ہوں۔					
32۔ مجھے ایسا لگتا ہے کہ جب کبھی میں کلاس میں سوال پوچھتی ہوں تو میری ریاضی کی اُستانی صاحبہ مجھے نظر انداز کرتی ہیں۔					
33۔ میری ریاضی کی اُستانی صاحبہ مجھے احساس دلاتی ہیں کہ میں ریاضی میں اور اچھا کام کرنے کی صلاحیت رکھتی ہوں۔					
34- ریاضی کے سوال میرے لئے ایک کھیل کی طرح ہوتے ہیں جنھیں میں کھیلنا اور جیتنا چاہتی ہوں۔					
35- ہم ریاضی کو روزمرہ زندگی میں استعمال کئے بغیر بھی اچھی زندگی گزار سکتے ہیں۔					
36- مجھے اعتماد ہے کہ میں بآسانی ریاضی میں کامیاب ہو سکتی ہوں۔					

P-3 (9th Grade_Girls)

انتہائی غیر متفق	غیر متفق	معلوم نہیں	متفق	انتہائی متفق	
					12-میں چاہے جتنی بھی کوشش کرلوں ریاضی سمجھ نہیں سکتی۔
					13- میں اپنے والدین سے بلا جھجک ریاضی میں درپیش اپنے مسائل کے بارے میں بات کر لیتی ہوں۔
					14- ریاضی کی اُستانی صاحبہ کی غیر معیاری تدریس کی وجہ سے میں ریاضی میں فیل ہوتی ہوں۔
					15- میں ریاضی کو سیکھنے کے لئے پُر جوش ہو جاتی ہوں جب میں سوال کو ٹھیک حل کر لیتی ہوں۔
					16- ریاضی کو سمجھنا بہت مشکل ہے۔
					17- ریاضی میں لڑکیوں کی کارکردگی لڑکوں کی نسبت اچھی ہوتی ہے۔
					18- میری ریاضی کی اُستانی صاحبہ صرف ذہین طالبات کو پسند کرتی ہیں۔
					19-ریاضی میں صرف سوال کا درست جواب آنا چاہیئے اوراس میں کچھ نہیں
					20- میرے والدین چاہتے ہیں کہ ان کے بیٹوں/لڑکوں کو ریاضی میں اچھا ہونا چاہیے۔
					21- اسکول میں پڑھایا جانے والا ریاضی حقیقی زندگی کے ساتھ کوئی مطابقت نہیں رکھتا۔
					22- میری ریاضی کی اُستانی صاحبہ ہمیں بڑے دوستانہ ماحول میں پڑھاتی ہیں۔
					23- اسکول میں ریاضی کو لازمی مضمون نہیں ہونا چاہیئے۔
					24- اگر مجھے کوئی سوال سمجھ نہ آئے تو میری ریاضی کی اُستانی صاحبہ میری مدد کرتی ہیں۔

P-2 (9th Grade_Girls)

سوالنامہ (حصہ اول)

ہدایات:

نیچے دیئے گئے ہر بیان کے سامنے 5 ممکنہ جوابات کے لیئے کالم دیئے گئے ہیں۔ ہر بیان کو غور سے پڑھیئے اور ان 5 ممکنہ جوابات میں سے جو آپ کے نزدیک بہترین جواب ہے اُس خانے میں ✓ کا نشان لگا دیں۔

	انتہائی متفق	متفق	معلوم نہیں	غیر متفق	انتہائی غیر متفق
1- ریاضی تمام مضامین میں سب سے زیادہ اہم ہے۔					
2- میں کسی کی مدد کے بغیر سوال کو خود حل کرنے کی کوشش کرتی ہوں۔					
3- مجھے ریاضی کا مضمون پسند ہے کیونکہ اس میں نمبر اچھے آتے ہیں۔					
4- میری ریاضی کی اُستانی صاحبہ مجھے سوال پوچھنے اور ریاضی سیکھنے میں میری حوصلہ افزائی کرتی ہیں۔					
5- اگر ہم اپنی تعریف کروانا چاہتے ہیں تو ہمیں ریاضی میں بہت اچھے نمبر حاصل کرنا ہوں گے۔					
6- اگر مجھے ضرورت ہو تو میرے والدین میرے لئے ریاضی کی ٹیوشن کا انتظام کرتے ہیں۔					
7- ریاضی سے منسلک شعبے صرف لڑکوں کے لئے موزوں ہیں۔					
8- میں ریاضی کا نیا سبق پہلے ہی سے تیار کرنا چاہتی ہوں جو میری اُستانی صاحبہ نے اگلے دن جماعت میں پڑھانا ہوتا ہے۔					
9- ریاضی کے بغیر کسی ٹیکنالوجی کا وجود نہیں۔					
10- میری ریاضی کی اُستانی صاحبہ کا تمام طالبات کے ساتھ ایک جیسا رویہ نہیں ہے۔					
11- میں اپنی ہچکچاہٹ کی وجہ سے جماعت میں اُستانی صاحبہ سے دورانِ سبق کچھ نہیں پوچھتی۔					

شناختی نمبر۔

عمومی معلومات

۱۔آپ کی عمر۔---------- ۲۔آپ کس جماعت میں پڑھتی ہیں۔---------- ۳۔آپ کے سکول کا نام۔----------------------

۵۔ آپ کے والد صاحب کی تعلیم (درج ذیل میں سے کسی ایک پر × لگائیں)

(ا)۔ لکھنا پڑھنا نہیں جانتے۔ ☐

(ب)۔ پرائمری تعلیم ☐

(ج)۔ ہائی سکول میٹرک/انٹرمیڈیٹ ☐

(د)۔ اعلیٰ تعلیم ☐

۶۔ آپ کے والد صاحب کیا ملازمت کرتے ہیں؟

۷۔ آپ کی والدہ صاحبہ کی تعلیم (درج ذیل میں سے کسی ایک پر × لگائیں)

(ا)۔ لکھنا پڑھنا نہیں جانتیں۔ ☐

(ب)۔ پرائمری تعلیم ☐

(ج)۔ ہائی سکول میٹرک/انٹرمیڈیٹ ☐

(د)۔ اعلیٰ تعلیم ☐

۸۔کیا آپ کی والدہ صاحبہ ملازمت کرتی ہیں؟ ہاں ☐ نہیں ☐

۹۔ کتنے ہیں؟ آپ کے بھائی --------- آپ کی بہنیں۔---------- بہن بھائیوں میں آپ کا نمبر۔--------

۱۰۔کیا آپ کے خاندان، رشتے دار یا دوستوں میں سے کسی کا پیشہ ریاضی یا کمپیوٹر سے منسلک ہے؟ ہاں ☐ نہیں ☐

۱۱۔وہ کون ہیں؟

آپ سے رشتہ	پیشہ	تعلیم	آپ کی ریاضی میں مدد کرتے ہیں؟ (ہاں / نہیں)
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۱۲۔کیا آپ سکول کے بعد ٹیوشن پڑھتی ہیں؟ ہاں ☐ نہیں ☐

۱۳۔آپ کے خیال میں کس مضمون کی ٹیوشن پڑھنا سب سے ضروری ہے؟ -----------------

P-6 (9th Grade-Boys)

	انتہائی متفق	متفق	معلوم نہیں	غیر متفق	انتہائی غیر متفق
51۔ میرے اُستاد صاحب ریاضی میں میری کارکردگی میں دلچسپی لیتے ہیں۔					
52۔ میرے والدین مجھے یہ احساس دلاتے ہیں کہ ریاضی ایک مشکل اور خشک مضمون ہے اور میں کمزور ہوں۔					
53۔ مجھے ریاضی اپنے اُستاد صاحب کی وجہ سے اچھا نہیں لگتا۔					
54۔ میرے والدین میری حوصلہ شکنی کرتے ہیں اگر میں ان سے چیزوں کی وجوہات پوچھوں یا سوال کروں۔					
54۔ میرے والدین میری حوصلہ شکنی کرتے ہیں اگر میں ان سے چیزوں کی وجوہات پوچھوں یا سوال کروں۔					
55۔ اگر ہمیں ریاضی آتا ہو تو ہم با آسانی وظیفہ حاصل کر سکتے ہیں یا تعلیمی اخراجات کو پورا کرنے کیلئے عارضی ملازمت حاصل کر سکتے ہیں۔					
56۔ ریاضی کے اُستاد صاحب کم ذہین طلبا کو جماعت میں آگے بیٹھنے نہیں دیتے۔					
57۔ خواتین اساتذہ کا ریاضی کا طریقہ تدریس مرد اساتذہ کی نسبت غیر معیاری ہوتا ہے۔					

انتہائی غیر متفق	غیر متفق	معلوم نہیں	متفق	انتہائی متفق	
					37- میرے ریاضی کے اُستاد صاحب کا خیال ہے کہ میں ریاضی اور سائنس سے منسلک شعبہ میں ترقی کر سکتا ہوں۔
					38- میرے ریاضی کے اُستاد صاحب مشق سے پہلے دیا گیا مواد نہیں سمجھاتے بلکہ سیدھا مشق کے سوال سمجھانا اور حل کرنا شروع کر دیتے ہیں۔
					39- میں جماعت میں موجود دوسرے بچوں کی نسبت ریاضی میں اچھا نہیں ہوں۔
					40- میرے والدین کا خیال ہے کہ ریاضی صرف لڑکوں کے لئے ضروری ہے لڑکیوں کے لئے نہیں۔
					41- میں جماعت میں ریاضی کے مطالعے سے لطف اندوز ہوتا ہوں۔
					42۔میرے ریاضی کے اُستاد صاحب کہتے ہیں کہ ریاضی مشکل ہے اور میں اسے نہیں پڑھ سکتا۔
					43۔ ریاضی انسان کے دماغ کی نشو ونما میں مدد کرتا ہے اور سوچنا سکھاتا ہے۔
					44۔میرے اُستاد صاحب کے پاس ریاضی کا بہت علم ہے۔
					45- میرے والدین ریاضی کے سوال حل کرنے میں میری مدد کرتے ہیں۔
					46۔میرے ریاضی میں اچھے نمبر بھی آجائیں تو بھی مجھے ریاضی پسند نہیں۔
					47- میں ریاضی میں اپنے اُستاد صاحب کی مدد کی وجہ سے کامیاب ہوتا ہوں۔
					48۔میں نے اپنے والدین کو اکثر یہ کہتے ہوئے سُنا ہے کہ وہ بھی ریاضی میں کمزور تھے۔
					49۔ یہ بہت مشکل ہے کہ ریاضی کی اُستاد صاحب میری تعریف کریں۔
					50۔ریاضی میرے لئے سب سے زیادہ مشکل مضمون ہے۔

شناختی نمبر۔

سوالنامہ (حصہ دوم)

ہدایات: نیچے دیئے گئے ہر بیان کے سامنے 5 ممکنہ جوابات کے لیئے کالم دیئے گئے ہیں۔ ہر بیان کو غور سے پڑھیئے اور ان 5 ممکنہ جوابات میں سے جو آپ کے نزدیک بہترین جواب ہے اُس خانے میں ✓ کا نشان لگادیں۔

	انتہائی متفق	متفق	معلوم نہیں	غیر متفق	انتہائی غیر متفق
25- میں ریاضی میں بہتر کارکردگی کا مظاہرہ نہیں کرسکتا۔					
26- ملک کی ترقی کے لئے ریاضی کا مضمون پڑھنا بہت ضروری ہے۔					
27- مجھے کبھی بھی ریاضی کا اچھا استاد یا اُستانی صاحبہ نہیں ملی۔					
28- ریاضی غیر دلچسپ اور اُکتا دینے والا مضمون ہے کیونکہ ہم کوئی چیز اپنے الفاظ میں بیان نہیں کر سکتے۔					
29- اگر میں کسی دن ریاضی کا ہوم ورک نہ کرسکوں تو میرے اُستاد صاحب وجہ جانے یا مانے بغیر مجھے سزا دے دیتے ہیں۔					
30- میرے ریاضی کے اُستاد صاحب ریاضی کے تصورات بہت تفصیل کے ساتھ مثالوں سے سمجھاتے ہیں۔					
31۔ میں ریاضی کی وجہ سے پریشان اور بے چین ہو جاتا ہوں۔					
32۔ مجھے ایسا لگتا ہے کہ جب کبھی میں کلاس میں سوال پوچھتا ہوں تو میرے ریاضی کے اُستاد صاحب مجھے نظر انداز کرتے ہیں۔					
33۔ میرے ریاضی کے اُستاد صاحب مجھے احساس دلاتے ہیں کہ میں ریاضی میں اور اچھا کام کرنے کی صلاحیت رکھتا ہوں۔					
34- ریاضی کے سوال میرے لئے ایک کھیل کی طرح ہوتے ہیں جنھیں میں کھیلنا اور جیتنا چاہتا ہوں۔					
35- ہم ریاضی کو روزمرہ زندگی میں استعمال کئے بغیر بھی اچھی زندگی گزار سکتے ہیں۔					
36- مجھے اعتماد ہے کہ میں بآسانی ریاضی میں کامیاب ہوسکتا ہوں۔					

P-3 (9th Grade-Boys)

	انتہائی متفق	متفق	معلوم نہیں	غیر متفق	انتہائی غیر متفق
12-میں چاہے جتنی بھی کوشش کرلوں ریاضی سمجھ نہیں سکتا۔					
13- میں اپنے والدین سے بلا جھجک ریاضی میں درپیش اپنے مسائل کے بارے میں بات کر لیتا ہوں۔					
14- میں ریاضی کے اُستاد صاحب کی غیر معیاری تدریس کی وجہ سے میں ریاضی میں فیل ہوتا ہوں۔					
15- میں ریاضی کو سیکھنے کے لئے پُر جوش ہو جاتا ہوں جب میں سوال کو ٹھیک حل کر لیتا ہوں۔					
16- ریاضی کو سمجھنا بہت مشکل ہے۔					
17- ریاضی میں لڑکیوں کی کارکردگی لڑکوں کی نسبت اچھی ہوتی ہے۔					
18- میرے ریاضی کی اُستاد صاحب صرف ذہین طلباً کو پسند کرتے ہیں۔					
19-ریاضی میں صرف سوال کا درست جواب آنا چاہیئے اور اس میں کچھ نہیں					
20- میرے والدین چاہتے ہیں کہ ان کے بیٹوں/لڑکوں کو ریاضی میں اچھا ہونا چاہیے۔					
21- اسکول میں پڑھایا جانے والا ریاضی حقیقی زندگی کے ساتھ کوئی مطابقت نہیں رکھتا۔					
22- میرے ریاضی کی اُستاد صاحب ہمیں بڑے دوستانہ ماحول میں پڑھاتے ہیں۔					
23-اسکول میں ریاضی کو لازمی مضمون نہیں ہونا چاہیئے۔					
24- اگر مجھے کوئی سوال سمجھ نہ آئے تو میرے ریاضی کے اُستاد صاحب میری مدد کرتے ہیں۔					

سوالنامہ (حصہ اول)

ہدایات:

نیچے دیئے گئے ہر بیان کے سامنے 5 ممکنہ جوابات کے لیئے کالم دیئے گئے ہیں۔ ہر بیان کو غور سے پڑھیئے اور ان 5 ممکنہ جوابات میں سے جو آپ کے نزدیک بہترین جواب ہے اُس خانے میں ✓ کا نشان لگا دیں۔

	انتہائی متفق	متفق	معلوم نہیں	غیر متفق	انتہائی غیر متفق
1- ریاضی تمام مضامین میں سب سے زیادہ اہم ہے۔					
2- میں کسی کی مدد کے بغیر سوال کو خود حل کرنے کی کوشش کرتا ہوں۔					
3- مجھے ریاضی کا مضمون پسند ہے کیونکہ اس میں نمبر اچھے آتے ہیں۔					
4- میرے ریاضی کے اُستاد صاحب مجھے سوال پوچھنے اور ریاضی سیکھنے میں میری حوصلہ افزائی کرتے ہیں۔					
5- اگر ہم اپنی تعریف کروانا چاہتے ہیں تو ہمیں ریاضی میں بہت اچھے نمبر حاصل کرنا ہوں گے۔					
6- اگر مجھے ضرورت ہو تو میرے والدین میرے لئے ریاضی کی ٹیوشن کا انتظام کرتے ہیں۔					
7- ریاضی سے منسلک شعبے صرف لڑکوں کے لئے موزوں ہیں۔					
8- میں ریاضی کا نیا سبق پہلے ہی سے تیار کرنا چاہتا ہوں جو میرے اُستاد صاحب نے اگلے دن جماعت میں پڑھانا ہوتا ہے۔					
9- ریاضی کے بغیر کسی ٹیکنالوجی کا وجود نہیں۔					
10- میرے ریاضی کے اُستاد صاحب کا تمام طلباً کے ساتھ ایک جیسا رویہ نہیں ہے۔					
11- میں اپنی ہچکچاہٹ کی وجہ سے جماعت میں اُستاد صاحب سے دورانِ سبق کچھ نہیں پوچھتا۔					

شناختی نمبر۔

عمومی معلومات

۱۔آپ کی عمر۔---------- ۲۔آپ کس جماعت میں پڑھتے ہیں۔--------- ۳۔آپ کے سکول کا نام۔--------------------

۵۔ آپ کے والد صاحب کی تعلیم (درج ذیل میں سے کسی ایک پر × لگائیں)

(ا)۔ لکھنا پڑھنا نہیں جانتے۔ ☐

(ب)۔ پرائمری تعلیم ☐

(ج)۔ ہائی سکول میٹرک/انٹرمیڈیٹ ☐

(د)۔ اعلیٰ تعلیم ☐

۶۔ آپ کے والد صاحب کیا ملازمت کرتے ہیں؟

۷۔ آپ کی والدہ صاحبہ کی تعلیم (درج ذیل میں سے کسی ایک پر × لگائیں)

(ا)۔ لکھنا پڑھنا نہیں جانتیں۔ ☐

(ب)۔ پرائمری تعلیم ☐

(ج)۔ ہائی سکول میٹرک/انٹرمیڈیٹ ☐

(د)۔ اعلیٰ تعلیم ☐

۸۔کیا آپ کی والدہ صاحبہ ملازمت کرتی ہیں؟ ہاں ☐ نہیں ☐

۹۔ کتنے ہیں؟ آپ کے بھائی --------- آپ کی بہنیں۔---------- بہن بھائیوں میں آپ کا نمبر۔--------

۱۰۔کیا آپ کے خاندان، رشتے دار یا دوستوں میں سے کسی کا پیشہ ریاضی یا کمپیوٹر سے منسلک ہے؟ ہاں ☐ نہیں ☐

۱۱۔وہ کون ہیں؟

آپ سے رشتہ	پیشہ	تعلیم	آپ کی ریاضی میں مدد کرتے ہیں؟(ہاں / نہیں)
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۱۲۔کیا آپ سکول کے بعد ٹیوشن پڑھتے ہیں؟ ہاں ☐ نہیں ☐

۱۳۔آپ کے خیال میں کس مضمون کی ٹیوشن پڑھنا سب سے ضروری ہے؟ -----------------

APPENDIX-3

Appendix 3A

Table 3A.1. Effect of exogenous on Endogenous variables for trimmed Model 1 of cause & effect of students' perception

Endogenous Variables	Causal Variables			
	Parents		Teacher	
	Unst.	St.	Unst.	St.
Student				
Direct Effect	0.242	0.172	0.192	0.401
Total Indirect	0.000	0.000	0.000	0.000
Total Effect	0.242	0.172	0.192	0.401
MI				
Direct Effect	0.000	0.000	0.167	0.277
Total Indirect	0.136	0.077	0.108	0.179
Total Effect	0.136	0.077	0.275	0.457
MB				
Direct Effect	0.108	0.087	0.080	0.188
Total Indirect	0.029	0.023	0.058	0.136
Total Effect	0.137	0.110	0.138	0.324

Table 3A.2. Effects (direct & indirect) of Endogenous on other Endogenous variables for Trimmed model 1

Endogenous Variables	Causal Variables			
	Student		Mathematics Interest (MI)	
	Unst.	St.	Unst.	St.
MI				
Direct Effect	0.562	0.447	0.000	0.000
Total Indirect	0.000	0.000	0.000	0.000
Total Effect	0.562	0.447	0.000	0.000
MB				
Direct Effect	0.000	0.000	0.210	0.298
Total Indirect	0.118	0.133	0.000	0.000
Total Effect	0.118	0.133	0.210	0.298

Appendix 3B

Table 3B.1. Causal paths of Trimmed Model 2 of mathematics attitude formation

Paths			Unstd.	S.E.	t-values	Std.
TP	→	MSC	.127***	.029	4.391	.134
TE	→	MSC	.190***	.023	8.123	.245
PE	→	MSC	.385***	.035	11.060	.256
TB	→	MSC	.137***	.028	4.919	.137
MSC	→	MSE	.059***	.013	4.587	.125
TE	→	MSE	.082***	.010	8.084	.224
PH	→	MSE	.112***	.019	5.759	.146
TE	→	MI	.266***	.030	8.859	.209
MSE	→	MI	.455***	.077	5.888	.130
MSC	→	MI	.807***	.038	21.506	.491
MI	→	MB	.199***	.019	10.339	.279
MSE	→	MB	.375***	.064	5.873	.150
PS	→	SST	.258***	.036	7.076	.183
TP	→	MB	.202***	.029	7.023	.182
TB	→		-.055***	.016	-3.388	-.089

Table 3B.2. Correlation coefficients between the exogenous variables in the Trimmed Model 2

Variables			Correlation coef.
TP	←→	TB	.481
TB	←→	TE	.462
TP	←→	TE	.590
PH	←→	TE	.191
PS	←→	PE	-.243
MEdu	←→	FEdu	.515
FEdu	←→	PH	.225
FEdu	←→	PE	.124
MEdu	←→	PH	.234
MEdu	←→	PE	.117
FEdu	←→	FATH_JOB	.321
FATH_JOB	←→	PH	.091
MEdu	←→	FATH_JOB	.092

Standardized Total Effects of Trimmed Model 2

	PE	TE	TB	TP	PH	MSC	MSE	PS	MI
MSC	.256	.245	.137	.134	.000	.000	.000	.000	.000
MSE	.032	.255	.017	.017	.146	.125	.000	.000	.000
MI	.130	.362	.069	.068	.019	.507	.130	.000	.000
SST	.000	.000	-.089	.000	.000	.000	.000	.183	.000
MB	.041	.139	.022	.203	.027	.160	.187	.000	.279

Standardized Direct Effects of Trimmed Model 2

	PE	TE	TB	TP	PH	MSC	MSE	PS	MI
MSC	.256	.245	.137	.134	.000	.000	.000	.000	.000
MSE	.000	.224	.000	.000	.146	.125	.000	.000	.000
MI	.000	.209	.000	.000	.000	.491	.130	.000	.000
SST	.000	.000	-.089	.000	.000	.000	.000	.183	.000
MB	.000	.000	.000	.182	.000	.000	.150	.000	.279

Standardized Indirect Effects of Trimmed Model 2

	PE	TE	TB	TP	PH	MSC	MSE	PS	MI
MSC	.000	.000	.000	.000	.000	.000	.000	.000	.000
MSE	.032	.031	.017	.017	.000	.000	.000	.000	.000
MI	.130	.154	.069	.068	.019	.016	.000	.000	.000
SST	.000	.000	.000	.000	.000	.000	.000	.000	.000
MB	.041	.139	.022	.022	.027	.160	.036	.000	.000

Appendix 3C

Table 3C.1. Causal paths of Trimmed Model 2 for Girls of mathematics attitude formation

Paths			Unstd.	S.E.	t-values	Std.
TP	→	MSC	.170***	.046	3.732	.161
TE	→	MSC	.189***	.037	5.079	.221
PE	→	MSC	.430***	.053	8.069	.279
TB	→	MSC	.126**	.047	2.706	.110
MSC	→	MSE	.064***	.017	3.819	.149
TE	→	MSE	.086***	.015	5.796	.232
PH	→	MSE	.138***	.028	4.964	.183
TE	→	MI	.248***	.048	5.185	.175
MSE	→	MI	.777***	.124	6.276	.202
MSC	→	MI	.826***	.054	15.299	.497
MI	→	MB	.191***	.028	6.940	.276
MSE	→	MB	.624***	.102	6.127	.234
PS	→	SST	.205***	.050	4.113	.156
TP	→	MB	.168***	.045	3.719	.138
TB	→		-.112***	.025	-4.496	-.174

** p < .01; *** p < .001

Table 3C.2. Correlation coefficients between the exogenous variables in the Girls' Trimmed Model 2

Variables			Correlation coef.
TP	←→	TB	.427
TB	←→	TE	.444
TP	←→	TE	.540
PH	←→	TE	.225
PS	←→	PE	-.257
MEdu	←→	FEdu	.515
FEdu	←→	PH	.179
FEdu	←→	PE	.144
MEdu	←→	PH	.218
MEdu	←→	PE	.119
FEdu	←→	FATH_JOB	.305
FATH_JOB	←→	PH	.040
MEdu	←→	FATH_JOB	.057

Appendix 3D

Table 3D.1. Causal paths of Trimmed Model 2 for Boys of mathematics attitude formation

Paths			Unstd.	S.E.	t-values	Std.
TP	→	MSC	.104**	.038	2.776	.117
TE	→	MSC	.186***	.030	6.207	.259
PE	→	MSC	.358***	.046	7.759	.240
TB	→	MSC	.162***	.035	4.666	.175
MSC	→	MSE	.052**	.019	2.773	.105
TE	→	MSE	.079***	.014	5.700	.219
PH	→	MSE	.088**	.027	3.233	.113
TE	→	MI	.279***	.038	7.331	.240
MSE	→	MI	.256**	.097	2.621	.079
MSC	→	MI	.777***	.051	15.108	.480
MI	→	MB	.195***	.027	7.180	.266
MSE	→	MB	.227**	.082	2.760	.096
PS	→	SST	.183***	.051	3.586	.128
TP	→	MB	.221***	.038	5.841	.210
TB	→		**.010**	.020	.487	.018

** p < .01; *** p < .001

Table 3D.2. Correlation coefficients between exogenous variables in the Boys' Trimmed Model-2

Variables			Correlation coef.
TP	←→	TB	.498
TB	←→	TE	.477
TP	←→	TE	.624
PH	←→	TE	.171
PS	←→	PE	-.199
MEdu	←→	FEdu	.515
FEdu	←→	PH	.261
FEdu	←→	PE	.101
MEdu	←→	PH	.228
MEdu	←→	PE	.101
FEdu	←→	FATH_JOB	.336
FATH_JOB	←→	PH	.130
MEdu	←→	FATH_JOB	.124

Standardized Total Effects of Boys' Trimmed Model 2

	PE	TE	TB	TP	PH	MSC	MSE	PS	MI
MSC	.240	.259	.175	.117	.000	.000	.000	.000	.000
MSE	.025	.246	.018	.012	.113	.105	.000	.000	.000
MI	.117	.384	.085	.057	.009	.488	.079	.000	.000
SST	.000	.000	.018	.000	.000	.000	.000	.128	.000
MB	.033	.125	.024	.227	.013	.140	.117	.000	.266

Standardized Direct Effects of Boys' Trimmed Model 2

	PE	TE	TB	TP	PH	MSC	MSE	PS	MI
MSC	.240	.259	.175	.117	.000	.000	.000	.000	.000
MSE	.000	.219	.000	.000	.113	.105	.000	.000	.000
MI	.000	.240	.000	.000	.000	.480	.079	.000	.000
SST	.000	.000	.018	.000	.000	.000	.000	.128	.000
MB	.000	.000	.000	.210	.000	.000	.096	.000	.266

Standardized Indirect Effects of Boys' Trimmed Model 2

	PE	TE	TB	TP	PH	MSC	MSE	PS	MI
MSC	.000	.000	.000	.000	.000	.000	.000	.000	.000
MSE	.025	.027	.018	.012	.000	.000	.000	.000	.000
MI	.117	.144	.085	.057	.009	.008	.000	.000	.000
SST	.000	.000	.000	.000	.000	.000	.000	.000	.000
MB	.033	.125	.024	.016	.013	.140	.021	.000	.000

Appendix 3E

Table 3D.1. Unstandardized and Standardized measures of Path coefficients

Causal Paths			Estimate (β)	S.E.	C.R.	Std. Regression (b)
TB	→	MSC	.152***	.027	5.571	.147
TE	→	MSC	.187***	.023	8.046	.241
TP	→	MSC	.198***	.029	6.823	.202
MSC	→	MSE	.062***	.013	4.823	.134
TE	→	MSE	.097***	.010	9.723	.271
TE	→	MIE	.106***	.012	9.123	.252
MSC	→	MIE	.070***	.015	4.848	.130
MSE	→	MIE	.217***	.030	7.262	.185
TE	→	MIA	.064***	.019	3.370	.075
MIE	→	MIA	.294***	.038	7.752	.145
MSC	→	MIA	.602***	.025	24.178	.549
MSE	→	MBU	.208***	.031	6.721	.171
MIE	→	MBU	.143***	.026	5.554	.139
TB	→	SST	-.068***	.016	-4.174	-.111
MSE	→	MIL	.698***	.135	5.188	.569
TE	→	MBN	.043***	.009	4.723	.127
MSC	→	MIL	.093***	.022	4.303	.166
MIA	→	MBI	.575***	.040	14.521	1.015
MBU	→	MBN	.527***	.080	6.605	.683

Variances: (complete - Default model)

	Estimate	S.E.	C.R.	P
TB	14.892	.561	26.539	***
TE	26.357	.989	26.650	***
TP	16.561	.620	26.728	***
e_sc	12.039	.452	26.626	***
e_se	2.945	.110	26.881	***
e_mi1	3.769	.140	27.004	***
e_mb1	4.660	.172	27.090	***
e_mi3	11.096	.421	26.334	***
e_mb3	3.003	.257	11.682	***
e_mb2	7.517	.599	12.557	***
e_mi2	5.031	.430	11.710	***
e_st	5.544	.206	26.948	***

Standardized Total Effects

	TP	TE	TB	MSC	MSE	MIE	MIA	MBU
MSC	.202	.241	.147	.000	.000	.000	.000	.000
MSE	.027	.303	.020	.134	.000	.000	.000	.000
MIE	.031	.340	.023	.155	.185	.000	.000	.000
MIA	.115	.257	.084	.572	.027	.145	.000	.000
MBU	.009	.099	.007	.044	.197	.139	.000	.000
SST	.000	.000	-.111	.000	.000	.000	.000	.000
MIL	.049	.213	.036	.242	.569	.000	.000	.000
MBI	.117	.261	.085	.581	.027	.147	1.015	.000
MBN	.006	.195	.004	.030	.134	.095	.000	.683

Standardized Direct Effects

	TP	TE	TB	MSC	MSE	MIE	MIA	MBU
MSC	.202	.241	.147	.000	.000	.000	.000	.000
MSE	.000	.271	.000	.134	.000	.000	.000	.000
MIE	.000	.252	.000	.130	.185	.000	.000	.000
MIA	.000	.075	.000	.549	.000	.145	.000	.000
MBU	.000	.000	.000	.000	.171	.139	.000	.000
SST	.000	.000	-.111	.000	.000	.000	.000	.000
MIL	.000	.000	.000	.166	.569	.000	.000	.000
MBI	.000	.000	.000	.000	.000	.000	1.015	.000
MBN	.000	.127	.000	.000	.000	.000	.000	.683

Standardized Indirect Effects

	TP	TE	TB	MSC	MSE	MIE	MIA	MBU
MSC	.000	.000	.000	.000	.000	.000	.000	.000
MSE	.027	.032	.020	.000	.000	.000	.000	.000
MIE	.031	.088	.023	.025	.000	.000	.000	.000
MIA	.115	.182	.084	.022	.027	.000	.000	.000
MBU	.009	.099	.007	.044	.026	.000	.000	.000
SST	.000	.000	.000	.000	.000	.000	.000	.000
MIL	.049	.213	.036	.076	.000	.000	.000	.000
MBI	.117	.261	.085	.581	.027	.147	.000	.000
MBN	.006	.068	.004	.030	.134	.095	.000	.000