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Parental Attitudes, Beliefs, and Expectations – Correlations with Students' Math Achievement in Austria

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Research Article

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Abstract

This study examines the role of parental attitudes, beliefs, and expectations in students' math achievement, controlling for the students' attitudes as well as the families' socioeconomic status (SES). The TIMSS 2019 data of Austrian Grade 4 students were investigated using a covariance-based structural equation modelling (CB-SEM) approach. The results showed partially significant, negative correlations between parental beliefs and achievement, and this correlation was mediated by students' attitudes. Furthermore, SES was a moderating factor, with a higher SES positively mediating the negative correlation between parental beliefs and achievement. However, parental math utility values were not significantly associated with math achievement. These findings suggest that for teachers, awareness of the association between parental attitudes, beliefs, and expectations and math achievement is essential to support students. Moreover, including parents in school life and ensuring good communication between all parties are vital for enhancing student learning.

Introduction

In a constantly evolving world, science, technology, engineering, and mathematics (STEM) jobs are gaining importance (European Commission, 2025). Between 2012 and 2022, the Programme for International Student Assessment (PISA) indicated that the number of students not achieving the minimum level of proficiency in mathematics increased, with around 25% of Austrian 15-year-olds not reaching the minimum proficiency level (OECD, 2023). This trend is critical, as numerous skills, one being mathematical competence, must be acquired to participate in society (Geary, 2011). One of the numerous reasons is the role of parents[1]; parents play an essential role in their children's lives and development, especially at a young age (Kelty & Wakabayashi, 2020). While parental involvement can assume various forms, this study focuses on parental attitudes, beliefs, and expectations and their correlation with students' math achievement. The results should support teachers and the educational sector in understanding possible associations, enabling them to adopt the necessary measures to support students.

However, the importance of math is often neglected, as can be seen, for example, in a study by the Overdeck Family Foundation and Simons Foundation, which found that parents viewed reading and writing as more useful to students' futures than math (Group Gordon, Inc., 2017). Similarly, Uscianowski et al. (2018) concluded that parents place significantly more emphasis on literary concepts and storybook reading compared to math. This lower value judgment, however, could be problematic, as a longitudinal study in Great Britain showed that poorer mathematical skills lead to severe consequences in the labour sector, with a higher chance of unemployment and generally less well-paid jobs and opportunities for career advancement (Geary, 2011). Furthermore, research has shown that children who struggle to keep up with math in the beginning of their educational career are prone to being below average in math achievement by the end of their formal education, leading to lifelong struggles (Geary, 2011). Consequently, supporting students who are struggling from an early age is essential.

According to the seminal work by Fan and Chen (2001), mathematical achievement is closely connected to attitudes towards the subject. Attitudes can hereby be understood as personal opinions concerning the subject as well as affection for or disapproval of mathematics (Philipp, 2007). These attitudes can be related to several factors, among which are parental beliefs towards the topic as well as parental expectations concerning their children's achievement (Mohr-Schroeder et al., 2017). According to Østbø and Zachrisson (2022), the educational achievement of children can be linked to their parents' attitudes. The value given to a subject (Eccles & Wigfield, 2002) and gender-based stereotypes (Gunderson et al., 2011) can be transferred through parental attitudes, beliefs, and expectations, thus influencing the academic performance of the students. Silver et al. (2021) analysed the correlation between parental math anxiety and student achievement and found that parents' beliefs about math were significantly associated with the children's math outcome; parents who believed that math was important had children who performed better in school, starting in

preschool. A child's attitude towards math and their educational achievement is consequently affected by the parents' expectations and support (Fan & Chen, 2001).

Although math attitudes have been analysed frequently by researchers, the definitions of "attitudes" vary (Wen & Dubé, 2022). Quaye and Pomeroy (2021) described attitudes as "ambiguous construct[s]" (p. 158) and identified the varying definitions of the term as the reason for differences in research results. Consequently, a definition for attitudes used in this study is necessary. Following Weerasinghe (2016), this study focuses on parental attitudes, beliefs, and expectations – three terms that are often used in connection to each other and sometimes even interchangeably under the overarching term of "attitudes" regarding parental involvement. However, these three terms must be distinguished. Attitudes can be defined as a tendency to like something or not, and consequently, math attitudes refer to a positive or negative mindset concerning the subject (Philipp, 2007). However, attitudes cannot be equated with emotions, as they are more stable and are not perceived as strongly as emotions (Philipp, 2007). Math attitudes fall along a broader spectrum than simply liking or disliking the subject and include positions like a general interest in math or fatigue caused by the topics discussed in math class (Philipp, 2007). In this context, parental math attitudes are closely related to parents' expectations for their child (Hascoët et al., 2021). While expectations focus on parents' specific ideas for their child's momentary math performance, aspirations are more long-term, concerning, for example, a child's qualifications or future career after school. However, this separation between expectations and aspirations is often neglected (Stamm, 2021). Beliefs are often used to describe attitudes, making beliefs a part of attitudes, but beliefs are more cognitive than attitudes and are thus differentiated from them (Wen & Dubé, 2022; Hwang & Son, 2021). Beliefs can also concern the importance of math in society and for children's future careers (Silver et al., 2021). Consequently, beliefs strongly correlate with parental behaviour and engagement with students' math activities (Silver et al., 2021).

Several factors are associated with the correlation between achievement and parental attitudes, beliefs, and expectations. The two most frequently mentioned ones are students' attitudes and the SES of the family (e.g. Fan & Chen, 2001; Usher, 2009). Usher (2009) stated that parental attitudes towards math can directly be associated with students' attitudes as parents openly voice their own attitudes, especially negative ones. However, a parent's positive mindset towards the subject can also impact children, making them more aware of the importance of math and possibly even leading them to enter careers in the STEM field (Rowan-Kenyon et al., 2012). A family's SES also correlates with parental attitudes towards school, with families with a lower SES generally perceiving math as less important (Kobra et al., 2024). Furthermore, SES can also compensate for negative parental attitudes, as children from a higher SES have more access to educational resources (Ding et al., 2022).While several studies have focused on the correlation of parental attitudes, beliefs, and expectations with students' math achievement in different countries (e.g. Kilic & Askin, 2013; Østbø & Zachrisson, 2022; Shapira-Lishchinsky & Zavelevsky, 2019), none have been performed concerning the Austrian context, which highlights the existing research gap, especially with the availability of TIMSS data. Therefore, the correlation between achievement and parental attitudes, beliefs, and expectations towards math in Austria, as mediated by student attitudes and with the moderation of SES, is analysed according to the TIMSS 2019 data in this study.

Research Questions

The aim of this study is to analyse the extent to which parental attitudes, beliefs, and expectations correlate with students' academic math achievement. To achieve this objective, the TIMSS 2019 data of Austrian Grade 4 students were investigated to address the following research question:

To what extent are parental attitudes, beliefs, and expectations towards math associated with overall student math achievement when controlling for student attitudes and the family's socioeconomic status?

This research question includes the following sub-questions:

1. What do Austrian TIMSS 2019 data reveal about parental attitudes, beliefs, and expectations concerning math?
2. To what extent do parental attitudes, beliefs, and expectations correlate with Grade 4 children's math achievement as measured by the 2019 TIMSS?
3. How do students' attitudes mediate the correlation between parental attitudes, beliefs, and expectations and math achievement?
4. How does the socioeconomic status of families of Grade 4 students in Austria moderate the correlation between parental attitudes, beliefs, and expectations and math achievement?
5. How can teachers respond to the correlation of parental attitudes, beliefs, and expectations with academic achievement?

Conceptual Framework

This study relies on several theories that, when arranged into categories and connected to past research, culminates into a conceptual framework (Ghanad, 2023).

Parental involvement in relation to educational achievement gained importance after years of strict separation between family and school (Epstein & Sander, 2000; Myrberg & Rosén, 2008, 2009; Shapira-Lishchinsky & Zavelevsky, 2019). Parental involvement became more multi-layered over time, and different modes of parental interaction and their effects on students' academic achievement became a central question of interest (see Alami, 2016; Bah, 2021; Barger et al., 2022). Multiple authors (see Fan and Chen, 2001; Kilic and Askin, 2013; Østbø & Zachrisson, 2021) critically scrutinized the term "parental involvement", questioning what it entails.

Attitudes towards Mathematics includes aspects of math anxiety (see Jansen et al., 2013; Dowker et al., 2019; Silver et al., 2021; Cvencek et al., 2021). Since 2014, Pinxten et al. (2014) stated that, although research has begun to focus on positive attitudes, especially in the course of positive psychology, these studies have shown numerous benefits for motivation and achievement (Hwang & Son, 2021). Math attitudes have been of interest to TIMSS since its first cycle in 1995 (Mullis et al., 2020). The Students Like Learning Mathematics scale had nine questions in the 2019 cycle, using a Likert scale to gain insights into students' attitudes towards the subject. Worldwide, the data showed that 45% of grade 4 students enjoyed doing math "very much", while 20% "do not like" math (Mullis et al., 2020). When comparing the Austrian data to the international average, the percentage of students who liked to learn math "very much" was slightly below average, at 40%. The number of students who liked to learn math "somewhat" corresponded to the international average. Furthermore, the percentage of students who did not like to learn math was slightly higher than the worldwide average, with one-fourth of Austrian students falling into this category (Mullis et al., 2020). Generally speaking, a correlation between math attitudes and achievement was evident in TIMSS 2019, as in every other cycle before, with those students who liked to learn math "very much" achieving higher scores than those who did not like it (Mullis et al., 2020). This result is reflected in the Austrian data too, with average achievement scores decreasing as the liking of math decreased (Mullis et al., 2020). However, the gap of the average achievement score between those who did not like to learn math and those who did very much was 26.8% lower than the international average (Mullis et al., 2020).

Parental Attitudes, Beliefs, and Expectations (as one part of parental involvement) concerning mathematics are of particular interest for this study. As an indirect form of influencing children in their mathematics learning, (Silver et al., 2021), as a mediator of achievement (Peixoto et al., 2023), the value assigned to the subject (Eccles & Wigfield, 2002) and gender-based stereotypes (Gunderson et al., 2011) that can be passed on, parents' approach to math can have such a substantial effect on students since, for children, parents are "interpreters of reality" (Šimunović & Babarović, 2020, p. 702). When parents want to support their children in their math performance, their own attitudes towards the subject and their self-perception of their math abilities, can lead them to reservations towards math exercises and struggles to support their children (Mohr-Schroeder et al., 2017), as also illustrated earlier by the Hoover-Dempsey and Sandler

model (1995), especially Walker et al.'s revised version (2005). Shifting attitudes, when parents gain more support from the school in engaging with their children at home and supporting their academic achievement (Peña, 2000; Davadas & Lay, 2017; Harun, 2021; Peixoto et al., 2023) highlight this role of schools and teachers in efforts to increase student proficiency.

Students' Attitudes have consistently shown a positive correlation between liking the subject and scoring higher points for all testing cycles in TIMSS, in particular, the scale Students Like Learning Mathematics. Students' attitudes towards math are especially relevant to the way in which students deal with and learn math. These findings have been mirrored by other researchers, generally speaking, when enjoying a subject, motivation to engage and learn increases (see Chen et al., 2022; Hwang and Son, 2021). On the other hand, negative attitudes, feelings of failure, and lack of confidence, correlate with lower math achievement (Usher, 2009; Rowan-Kenyon et al., 2012). (Hwang & Son, 2021). Like Dowker et al.'s (2019) conclusion, the general consensus is that math attitudes in primary school are mostly positive; however, students can still develop negative attitudes towards a subject at a young age (Markovits & Forgasz, 2017). A slow and often playful introduction to math can help to foster positive attitudes and better achievement, which can additionally prevent the development of negative attitudes (Mohr-Schroeder et al., 2017), and according to Evans and Field (2020), the transition between primary school and secondary education has been found to be particularly significant concerning math attitudes since the educational transition is an impactful time for students. Cultural values that are closely related to the country and national identity (Hunter, 2021; Zhang, 2019), as well as gender have been discussed as possibly being related to students' attitudes (Gunderson et al., 2011), with boys often showing more positive attitudes towards math, although academic achievement is higher for girls at the beginning of secondary education (Cvencek et al., 2021). Interestingly, Casad et al. (2015) stated that girls are prone to get math anxiety through teachers who have math anxiety themselves.

Family socio economic status (SES) is a way of positioning a family within society based on parental education and the occupation, including the household income (Conger & Donnellan, 2006). Findings from Fan (2001), Pan et al (2018) and Østbø et al. (2021) found a significant correlation between parental attitudes and the family SES; however, for the correlation between SES and students' motivation, they could not identify any significant mediation of parental attitudes. Children who enter school with different prior knowledge concerning math, caused by SES-related differences that are likely to manifest and even intensify during the children's school career (Garon-Carrier et al., 2018). An SES difference concerning math exposure is not solely based on parents engaging in math activities with their children but also based on the availability of such resources and materials, such as out-of-school math activities (Kobra et al., 2024) and cultural capital (Heppt et al., 2022). When investigating how SES is related to student achievement, the various dimensions of SES and cultural capital must be differentiated, as some factors can be passed down more easily from parents to children than others (Marsh et al., 2023). Parental education and occupation, for example, are closely linked to the parents themselves, while the family's wealth is easily transferrable to all family members and not solely bound to one person (Hällsten & Thaning, 2021). In their study, Heppt et al. (2022) identified the use of objectified cultural capital as determining SES, as it is more easily transmitted from parents to children than other forms of cultural capital. An example of inquiring about objectified cultural capital would be the question concerning the number of books available in the household, as seen in TIMSS context questionnaires.

The conceptual framework of this study is based on Ding et al. (2022), who investigated the correlation of parental attitudes towards school and children's academic achievement. For the analysis, psychological *suzhi* – which will be described in the following paragraphs – is used as a mediator, while the SES is the moderating factor (see Fig. 1).

Ding et al. (2022) described parental attitudes towards school (PAS) as an important variable in children's achievement. In this context, EVT is mentioned as being essential for the effects of parental attitudes and values that are connected to a subject. Not only can parental factors change the way students perceive school or a specific subject, but students'

behaviour and learning can also be linked to these perceptions (Ding et al., 2022). As described in Section 2.1.2, EVT "postulates that expectancies and values directly influence performance, persistence, and task choices" (Peixoto et al., 2023, p. 1564). As expectations and beliefs can be affected by the others' perceptions, expectations, and beliefs concerning a subject, as well as their reactions to previous achievement, EVT is often used in relation to students' motivation and achievement and can be linked to correlations with parental expectations and values (Peixoto et al., 2023). For example, Rodriguez et al. (2017) discovered that parental expectations and interest in their child's math education were positively related to students' valuing the subject and their math achievement. Especially for STEM subjects, research has shown that the utility value given to a domain by the parents is vital for students' further math achievement and guides students' own utility values (Nalipay et al., 2021). Similar results were also found by Peixoto et al. (2023), who stated that "parents' perspectives about math values, goals and learning seem to have a significant role in children's mathematical development, attitudes, values, and even achievement" (p. 1576). Utility values and their transmission can have severe consequences for students; parents who focus on positive utility values concerning STEM domains have children who are more prone to work in such a field later on (Nalipay et al., 2021). This transmission of parents' utility values concerning STEM subjects is, according to Šimunović et al. (2018), based on children's perception of their parents' interaction with STEM domains and their encouragement of interest for such subjects. This again links back to EVT and students' adoption of attitudes, beliefs, and general motivation to learn the subject based upon their parents' reaction to math activities, achievement, and so on (Nalipay et al., 2021). Apart from the correlation of utility values between parents and students, Nalipay et al. (2021) also identified a correlation between parental utility values and students' math achievement. This correlation was both direct and indirect, via the students' utility values.

To explain a possible correlation between PAS and academic performance, other factors that might influence this correlation must be considered. Therefore, Ding et al. (2022) used both mediating and moderating factors. A mediating factor describes which factors and processes influence the relationship between the independent and dependent variable (Fodouop Kouam, 2024). Conversely, the moderating factor acknowledges the fact that other factors can influence the correlation the researchers are investigating between the dependent and independent variables; therefore, the moderator is a factor that influences the relationship and might potentially strengthen or weaken the correlation (MacKinnon, 2011). In this study, the Chinese model of *suzhi* was analysed for the moderating role to describe the students' intrinsic factors that mediate parental attitudes, in this case, the external factors (Ding et al., 2022). The moderating factor can influence the role of PAS and, in Ding et al.'s (2022) study, was represented by the family's SES. According to the family investment model, out-of-school support in the form of parental involvement and available resources depends upon the family's SES (Duncan et al., 2015). Lower SES can lead to less time and financial abilities to invest in the child, which can have negative consequences for the child's development (Chen et al., 2022). Furthermore, the family investment model states that a higher SES can balance negative PASs (Ding et al., 2022).

Furthermore, students' attitudes concerning math is used as a mediating factor, as these attitudes play an essential role concerning achievement, with positive/negative attitudes correlating with positive/negative academic performance in this subject (Hwang & Son, 2021). The family SES, with possible consequences for the correlation of parental attitudes, beliefs, and expectations with achievement, takes up the moderating role. Including all these factors, the conceptual framework is shown in Fig. 2.

While the conceptual framework was derived from Ding et al.'s (2022) study, certain adaptations were taken to fit this study's focus. First, the focus for this study is narrower than in the study of Ding et al. (2022), with the analysis focusing solely on math, not the school as a whole, and a narrow definition of most of the factors. PAS is replaced by parental attitudes, beliefs, and expectations concerning math. Academic performance of the students focuses solely on the subject of math. Last, *suzhi* was replaced by students' attitudes, representing the intrinsic factors, due to the fact that *suzhi* is not as commonly used in Western research as it is in China (Wang, 2014).

Method

Design

The quantitative survey design of TIMSS 2019 allows for a secondary analysis to gain clear insights concerning the parent–child relationship of attitudes in Austria by using the sample of Grade 4 students and the parents of Grade 4 students. Ghanade (2013) summarised the area of application of surveys as follows: “It is especially beneficial when a researcher wants to describe the characteristics, attitudes, behavio[u]rs, and opinions of a large population” (p. 3797). secondary analysis (IEA TIMSS & PIRLS, n.d.; Fishbein et al., 2021). For purposes of this study, TIMSS 2019 data are used, since these data include the contextual background data as obtained from parents of Grade 4 students. In subsequent cycles, parent questionnaire data were not collected.

Sample

In Austria, the TIMSS 2019 data were collected from 259 schools throughout all nine Austrian regions in Spring of 2019. From each school at least one class, all of them Grade 4, participated in the study, resulting in a sample of 4,464 assessed students (Itzlinger-Bruneforth, 2020). As Austria opted to participate in the new eTIMSS, 1,964 students participated in the old pen-and-paper format. This allowed for identifying differences in the testing methods and ensured that the new form of computer-based testing did not influence the results to an extent that would hinder a comparison with results from past TIMSS testing (Institut des Bundes für Qualitätssicherung im österreichischen Schulwesen, n.d.-a.). These data were also described as bridge data (Fishbein et al., 2021). Furthermore, one parent per child was asked to complete the home questionnaire, resulting in available data from 4,464 parents of Grade 4 students.

Data and Variable Selection

Parental attitudes, beliefs, and expectations

For the TIMSS 2019 data in Austria, several items were administered in the form of the national-use data files, rendering them not publicly accessible, and access had to be requested before use. For the latent variable of parental attitudes, beliefs, and expectations, the items from the parent questionnaire focusing on attitudes, beliefs, or expectations (ASXH25A-G, L) were used for the explorative factor analysis. These questions stated specifically ´My child is good in Mathematics´, $My\chi ldcaneasilyfollowMathematics \in struction´$, My child likes Math´, `My child has to work harder in Mathematics than in other subjects´, ´My child needs Math to get ahead in life´, Í would be glad if my child chose a technical career´, ´For most careers one needs knowledge of Mathematics, Natural Science or Technology´, and ´Mathematics can be applied in real life´.

Math achievement

For this study, the overall math achievement of Austrian students was analysed using the Plausible Values, as, following the research aim, there was no need to look into specific content or cognitive domains, as the correlation to general math achievement was analysed.

Students’ attitudes

For analysing students’ attitudes, the TIMSS scale Students Like Learning Mathematics was used. This scale, which has been tested for reliability and validity (Yin & Fishbein, 2020), is based on the student context questionnaire, which

students complete in school within 30 minutes (Martin et al., 2017). The scale for students' liking mathematics suited the student context questionnaire for Grade 4 and Grade 8 students. The scale for TIMSS 2019 has nine items, all aimed at generating insights concerning students' attitudes towards the subject. All of these items are based on a Likert scale with the response options being "agree a lot", "agree a little", "disagree a little," and "disagree a lot". The scale is divided into three categories based on the cut score: "Very Much Like Learning Mathematics", "Somewhat Like Learning Mathematics", and "Do Not Like Learning Mathematics". For the first category, the cut score was defined as students answering, on average, five of the scale items with "agree a lot" and the four remaining with "agree a little". Students who scored at or higher than the cut-off score are defined as very much liking to learn math. The last category of students' not liking to learn math was fulfilled if students are at or below the cut-off score for this category, meaning that on average five statements were answered with "disagree a little" and the others with "agreeing a little". Students who are categorized as somewhat liking to learn math are the ones for whom neither of these descriptions apply (TIMSS & PIRLS International Study Center at Boston College, n.d.-a.).

Socioeconomic status

The Home Resources for Learning scale was designed for Grade 4 students, as it comprises items from the student and home questionnaires. Items that were included in this study are the number of books available at home and the number of home study supports from the student questionnaire; and parents answered the questions regarding the number of children's books as well as their highest level of education and occupation. In the end, the scale was divided into students with many resources, some resources, or few resources. These three categories were defined as follows: Students with many resources had scores that were higher or at the cut-off score, which was defined by 100 books at home, internet connection and their own room, more than 25 children's books, and parents of whom at least one had a university degree and at least one had a professional occupation. The cut-off score for students with few resources was defined by, on average, having less than 26 books, neither an internet connection nor their own room, less than 11 children's books, both parents not having education higher than upper-secondary education, and both not being small business owners or working in a clerical or professional job. Those students for whom neither of these descriptions applied were defined as having some resources at home (TIMSS & PIRLS International Study Center at Boston College, n.d.-b).

Analysis

This study utilised Structural Equation Modelling (SEM), with the aim of modelling and analysing correlations between the main latent variables of parental attitudes, beliefs, and expectations, as well as students' math achievement. Figure 3 presents the model. The variable ´Students´ Attitudes´ was included as mediator and family SES as moderator of this model. The model was based on the conceptual framework, as well as other theories and literature, stating that positive correlations exist between parental attitudes, beliefs, and expectations and math achievement (e.g. Fan & Chen, 2001). Additionally, students' attitudes towards a subject correlate with parental attitudes, beliefs and behaviours (e.g. Usher, 2009; Hwang & Son, 2021).

Stated as hypotheses, Fig. 2 therefore aims to test:

H1: Parental math beliefs have positive and significant effects on students' math achievement.

H2: Parental math utility values have positive and significant effects on students' math achievement.

H3: Parental math beliefs have positive and significant effects on students' math attitudes.

H4: Parental math utility values have positive and significant effects on students' math attitudes.

H5: Students' math attitudes have positive and significant effects on math achievement.

H6: Students' math attitudes mediate the correlation between parental math beliefs and math achievement.

H7: Students' math attitudes mediate the correlation between parental math utility values and math achievement.

H8: SES moderates the correlation between parental math beliefs and math achievement.

H9: SES moderates the correlation between parental math utility and math achievement.

Before beginning the SEM, a factor analysis was conducted to ensure that the items fit the latent variable (Orcan, 2018). This study employed an exploratory- (EFA) as well as a confirmatory factor analysis (CFA). The EFA analysis was conducted for the latent variable of parental attitudes, beliefs, and expectations using SPSS, with student weights applied to the data. Therefore, the items described were analysed first by examining the correlation matrix, which shows correlations between items. High correlations indicate that those items belong to the same latent variable (Harris & Gleason, 2022). The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was checked to ensure that correlations between the variables were large enough to justify using EFA (Howard, 2016). Having a KMO of 0.6 or larger is a prerequisite of EFA (Howard, 2016). Afterwards, the factor rotation occurred with the rotation method of varimax, resulting in a factor matrix depicting factor loadings, which show the relation of each variable with the potential latent variable (Harris & Gleason, 2022). The factor loadings can range between − 1 and 1, with loadings close to 0 indicating a low correlation between the item and the latent variable (Harris & Gleason, 2022). In general, Howard (2016) proposed loadings above 0.4 or below − 0.4 as indicating a belonging to the latent variable.

Subsequently, the CFA was conducted using AMOS for all four latent variables in the form of an individual CFA and then for all latent variables as a pooled CFA (Baharum et al., 2023). In this step, the model fit indices were analysed. Following Goretzko et al. (2024), this study relied on the comparative fit index (CFI) and Tucker-Lewis fit index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). Furthermore, χ^2 was examined in combination with the degrees of freedom. While not all possible indices should be used, there is no common consensus regarding which indices to use; however, several are used more frequently in combination, as they represent different goodness-of-fit criteria groupings (Schermelleh-Engel & Moosbrugger, 2003).

The exact numbers for when a model fits well vary depending on the literature analysed. However, the numbers listed above have been mentioned frequently as a general standard; thus, based upon several studies (e.g. Goretzko et al., 2024; Schermelleh-Engel and Moosbrugger, 2003), the cutoff scores above were used for this study. χ^2 is highly sensitive, especially with large sample sizes, as is the case with large-scale assessments like TIMSS, where χ^2 is not considered a suitable modification index since small changes have a significant impact, rendering χ^2 high (Alavi et al., 2020). Consequently, Alavi et al. (2020) recommended relying on other modification indices. Therefore, following other researchers in the field of parental involvement and achievement, a model was appropriate for this study, even if the χ^2-test was deficient, as long as the other indices indicated good model fit (e.g. Myrberg & Rosén, 2008).

In addition to confirming model fit indices and construct validity, convergent and composite reliability (CR) were analysed. Convergent validity was tested using average variance extracted (AVE) for every latent variable. AVE tests the degree to which the variance in the items can be explained by the latent variable (Santos & Cirillo, 2021). AVE must be greater than 0.5 for convergent validity (Cheung et al., 2023). CR shows that the items for a latent variable are in fact constantly measuring their latent variable. CR is reached when CR ≥ 0.6 (Baharum et al., 2023). For the TIMSS scales used in the analysis, Cronbach Alpha values for the scales as reported in the TIMSS 2019 technical report for Austria were considered to be used to indicate reliability. However, literature points out the limitations of Cronbach Alpha, such as problems with inversed items (Simcox, 2018) or the assumption that factor loadings are equal (tau-equivalence;

Zakariya, 2022), which is why CR was given the primary focus in this SEM analysis. Furthermore, CR allows to measure reliability not only for TIMSS scales but any set of items representing a latent variable. This is necessary, as not all latent variables of this study were derived from TIMSS scales.

Finally, factor loadings were considered for CFA. The factor loadings represent the correlation between an item and its latent variable, and their values lie between − 1 and + 1 (Harris & Gleason, 2022). Negative factor loadings in this context indicate a negative correlation, while positive values represent a positive correlation (Harris & Gleason, 2022). As with the model fit indices, various cut-off scores have been given in the literature; however, having all standardized factor loadings be greater than 0.5 is seen as a general standard (Cheung et al., 2023).

As a first step, the goodness-of-fit was analysed to provide insights into whether the data were represented well by the SEM (Kang & Ahn, 2021). As described in the conceptual framework, a mediator was included in the model. While most commonly adopted in regression analysis, mediation can also be conducted in SEM (Sathyanarayana & Mohanasundaram, 2025). For the analysis, indirect effects were used, which occur exactly when mediation is present. These indirect effects also must be tested for statistical significance, which is done with the help of bias-corrected confidence intervals provided by bootstrapping (Sathyanarayana & Mohanasundaram, 2025). For bootstrapping, the data set was resampled several times. One major advantage is that bootstrapping does not rely on a normal distribution of the indirect effects, making it robust (Sathyanarayana & Mohanasundaram, 2025).

Moderation in SEM is similar to moderation in regression analysis (Sardeshmukh & Vandenberg, 2017). To test the moderating effect of SES, interaction terms were used. If the interaction term was significant, the correlation between the independent and dependent variable was affected by the moderator (Sardeshmukh & Vandenberg, 2017). In other words, the correlation changes as the moderator assumes different values (Sardeshmukh & Vandenberg, 2017). Moderation is mostly depicted using graphical illustrations that represent how the variables differ when the moderator is high/low.

The IDB Analyzer was used for the preliminary analysis and descriptive statistics. SPSS was used for data preparation and the EFA, while SPSS´ AMOS was used for the CFA and SEM analysis.

Results

EFA and CFA

The EFA was conducted using the national Austrian data concerning parental attitudes, beliefs, and expectations, described in Section 3.2.1. First, the KMO was tested, and at 0.808, it fulfilled the criterion ≥ 0.6. Looking at the rotated component matrix (see Table 1), two latent variables became evident.

The first latent variable was labelled as ´Parent Math Beliefs, and the first four items were seen as relevant, all with loadings above 0.4. The item “Child has to work harder in math” had a negative loading because it was a reversed item. Consequently, for CFA and SEM, the reversed version of the item was used. The last four items could be assigned to the second latent variable, as all loadings were again greater than 0.4. Due to the topics of the items, the two latent variables were labelled as “Parent Math Beliefs” and “Parent Math Utility”. These variables were used in the SEM after a CFA was conducted.

The CFA analysed all latent variables individually. First, math achievement was examined looking at the model fit (χ^2 = 2.582) and 5 degrees of freedom resulting in χ^2/df = 0.5167. For the indices investigated for the model fit, all results indicated a good fit (CFI = 1.000, TLI = 1.000, RMSEA = 0.000, SRMR = 0.007). CR (0.974) and AVE (0.882) also fulfilled the criteria. Furthermore, standardized factor loadings were all close to 1 (all 0.94), indicating a good correlation

between the items and the latent variable. For all other variables, χ^2/df did not fulfil the criterion of being below 5, which was acceptable due to the other indices indicating good model fit and the sensitivity of χ^2 as described in earlier sections

Second, the model fit of students' attitudes was analysed for the CFA, with the following results: χ^2/df = 42.302, CFI = 0.965, TLI = 0.954, RMSEA = 0.096, SRMR = 0.0324. This model did not seem ideal, especially because RMSEA was above the cut-off score and χ^2/df was very high. Therefore, modification indices were analysed, leading to the conclusion that a covariance between the two reversed items ("I wish I would not have to study math" and "math is boring") would be useful. Furthermore, covariances were drawn between Items 1 and 2, Items 4 and 9, Items 5 and 8, and Items 6 and 7. These items each had a similar focus and formulation. With the newly implemented covariances, the model fit indices improved (χ^2/df = 10.603, CFI = 0.993, TLI = 0.989, RMSEA = 0.046, SRMR = 0.0148), rendering this measurement model a good fit. CR and AVE also were above the cut-off score. Concerning the factor loadings, a good correlation was found, with all standardized factor loadings being greater than 0.5.

For the family SES, the model fit led to a re-evaluation of the items, as the fit indices indicated no good model fit (χ^2/df = 86.669, CFI = 0.773, TLI = 0.682, RMSEA = 0.139, SRMR = 0.0696). Furthermore, three items showed factor loadings below the cut-off score. Therefore, an EFA was performed to obtain deeper insight into the relevant items. Subsequently, two items were eliminated (possession at home: own room and internet) due to low loadings. Afterwards, the CFA was carried out again, and one correlation was added between the number of books at home and the number of children's books indicated by the modification indices and justified due to the similarity of the items. Then the measurement model showed good model fit, with the exception of AVE being slightly below 0.5 (χ^2/df = 3.601, CFI = 1.000, TLI = 0.997, RMSEA = 0.024, SRMR = 0.0036, CR = 0.788, AVE = 0.486). Furthermore, all factor loadings were higher than 0.5.

Next, the CFA for the latent variable of parental math beliefs led to the following results: χ^2/df = 10.826, CFI = 0.998, TLI = 0.993, RMSEA = 0.047, SRMR = 0.0087, CR = 0.868, AVE = 0.623. The factor loadings were all between 0.69 and 0.85 and consequently greater than 0.5.

For the original parental math utility values, the goodness-of-fit indices were suitable; however, one item had a factor loading below the cut-off score of 0.5 (0.44). This item focused on parental happiness if the child were to work in a technical job later in life, an item not solely focusing on math but the broader term of a technical occupation, while all the other items included a specific mention of math. Furthermore, this item already showed loadings lower than the rest for this latent variable during the EFA. Consequently, this item was excluded from the measurement model. The new CFA was based on three items, the minimum number of items needed for the CFA to work. Due to the low number of items, the degrees of freedom were 0, leading to χ^2/df not being definable, and the same was true for TLI. The remaining model fit indices were suitable, except for RMSEA (CFI = 1, RMSEA = 0.413, SRMR = 0.000). CR also indicated a good fit; however, AVE was slightly below the cut-off score, at 0.434. The factor loadings were all above the cut-off score. Such a model is not ideal; however, due to the EFA, this model was accepted for the sake of this study.

Lastly, the overall model fit of all latent variables was determined through a pooled CFA. The model fit indices indicated a good model fit (χ^2/df = 8.159, CFI = 0.978, TLI = 0.975, RMSEA = 0.040, SRMR = 0.0426), which justified accepting minor deviations from the cut-off scores of individual CFAs. Furthermore, the varying cut-off scores presented in the literature were often higher/lower than those used in this study, allowing for values close to the proposed cut-off scores to be accepted. After the factor analysis was completed, the SEM could be carried out.

Parental Attitudes, Beliefs, and Expectations in Austria

The first research question asks the distribution of attitudes, beliefs, and expectations of parents of Grade 4 students in Austria.

The TIMSS 2019 data for Austria distinguished between general attitudes/beliefs of parents concerning the importance of math (in the SEM referred to as Parent Math Utility) and their expectations and beliefs about their children and their relationship to math (in the SEM referred to as Parent Math Beliefs). Concerning general attitudes and beliefs focusing on the importance of math, the following results were found:

Figure 3

Parent Math Utility Attitudes

Most parents of Grade 4 students agreed with the importance of math. For each statement, less than one-fifth of the parents disagreed. The highest agreement rate could be seen for the last item, namely that math is applicable to real life, as almost 89% agreed with the statement (agree a lot: 46.56%, *SE* = 1.10 and agree a little: 42.41%, *SE* = 1.17). The lowest agreement was seen for "occupations need skills in math/science/technology" with 18.55% of the parents not seeing the need for math in a job setting (disagree a lot: 2.86%, *SE* = 0.29 and disagree a little: 15.69%, *SE* = 0.64).

Regarding parental beliefs and expectations concerning their child and math, the following results were found:

Figure 4

Parental Math Beliefs Concerning Their Child's Relationship to Math

Most parents of Grade 4 students were of the opinion that their child liked math, with almost 80% agreeing with the statement (agree a lot: 47.24%, *SE* = 1.05 and agree a little: 32.42%, *SE* = 1.09). Even more parents expected their child to follow the math class easily (86.94%; agree a lot: 47.02%, *SE* = 0.90 and agree a little: 39.92%, *SE* = 0.87). This pattern was also reflected in the reversed item of children having to work harder in math than their colleagues.

Connected to parental expectations for their children was the item asking parents of Grade 4 students what they expect the highest educational qualification of their child to be. In contrast to the items mentioned before, this item is more focused on the future, with parents predicting their children's future – even though the children are only attending elementary school. These expectations were analysed to determine whether parents of Grade 4 students had high or exceeding expectations for their children, as those are closely connected to parental beliefs about students' math competences. Parental expectations for students' future educational careers can be seen in Fig. 5.

Figure 5

Parental Expectations Concerning Their Children's Highest Educational Qualification

Three categories were dominant: the child completing upper secondary education (33.03%, *SE* = 0.98), short-cycle tertiary education (27.85%, *SE* = 0.89), or a postgraduate degree (28.55%, *SE* = 1.27). The least number of parents of Grade 4 students (0.84%, *SE* = 0.20) expected their child to finish the lowest category, namely the lower secondary education. Consequently, the remaining 10% (*SE* = 0.56) of parents of Grade 4 students anticipated their child would earn a bachelor's degree or an equivalent educational qualification.

Lastly, parental gender beliefs concerning math were analysed. In this item for the home questionnaire, parents were asked who was more talented in math from five options, ranging from girls being more talented in math to none of the genders being more prone to succeed in math to boys being more skilled in this subject.

Figure 6

Parental Gender Beliefs

Correlation of Parental Attitudes, Beliefs, and Expectations with Math Attitudes

The goodness-of-fit indices are listed in Table 2.

All indices except χ^2/df had good fit. As discussed previously, the χ^2 test can be unreliable for large samples, which is why this model was used, despite the one deficient model fit index. After checking the model for goodness of fit, the regression estimates were generated (Table 3).

Testing Hypotheses 1 to 5 generated the following results: The path analysis showed a statistical significance between math achievement and parental beliefs. However, the correlation was negative, which meant that the first hypothesis could not be supported (β= -42.705, *SE* = 1.561, $p < 0.001$). Parents utility values were positively but insignificantly associated with math achievement (β = 2.136, *SE* = 1.893, $p > 0.05$), leading to a rejection of Hypothesis 2. Hypothesis 3 was supported, as there was a positive and significant association between parental beliefs and students' attitudes (β= 0.618, *SE* = 0.21, $p < 0.001$). Between parental utility values and students' attitudes, however, no significance was found (β= -0.019, *SE* = 0.030, $p > 0.05$). For the association between students' attitudes and math achievement, there was a significant positive correlation (β= 5.823, *SE* = 1.054, $p < 0.001$), so Hypothesis 5 was accepted. SES was significantly positively associated with math attitudes (β= -28.634, *SE* = 0.938, $p < 0.001$). This correlation is discussed further in the course of the moderation analysis. Furthermore, the standardized regression weights were examined, as shown in Table 4.

Analysis of the standardized regression estimates (see Table 4 and Fig. 8) revealed the strongest correlations between parental math beliefs and students' attitudes, as well as parental math beliefs and math achievement, with standardized estimates close to 0.5/-0.5. For the statistically significant correlation between math achievement and students' attitudes, only a small effect could be seen. SES and math achievement, however, showed a moderate effect with a standardized regression estimate of -0.466.

Figure 7

SEM with Path Coefficients

Mediation of Students' Attitudes

A majority of Grade 4 Austrian students reported to very much like learning math, with smaller percentages reporting liking it only somewhat or not at all. (see Fig. 8).

Figure 8

Students' Attitudes Towards Math

The average achievement revealed the same pattern (see Table 5), with those students who very much liked to learn math can be expected to achieve the highest average score, with a mean of 552 (*SE* = 2.54), followed by the mean of 538 (*SE* = 2.72) for students who somewhat liked it and an average score of 522 (*SE* = 2.90) for those students who did not like to learn math. Consequently, a relationship could be seen between students liking to learn math and their average test score, with scores declining the less students enjoyed learning mathematics.

The Students Like Learning Mathematics scale was also analysed based on the students' gender. The percentage of boys liking math very much was 12% higher than for the girls (boys: 46.6%, *SE* = 1.52; girls: 34.01%, *SE* = 1.36).

Although not included in the SEM, the item in the student questionnaire concerning the students' beliefs about gender and math talent was examined to compare the students' gender beliefs with parental attitudes. In contrast to the item in the home questionnaire, students were not asked who was more talented in math but who had to work harder in math.

Figure 10

Students' Gender Expectations

As for the parental beliefs, most students (67.66%, *SE* = 1.16) also believed girls and boys as having to work equally hard for math. However, while the less extreme form, one gender having to work a little harder, was almost the same for boys and girls, around 12% (*SE* = 0.87) of the students believed that girls had to work much harder than boys.

The mediation analysis was conducted using parental math beliefs and parental math utility as the independent variables and math achievement as the dependent variable. Students' attitudes assumed the mediating role, as described in the conceptual framework. The mediation analysis was performed by using indirect effects based on bootstrapping (2,000 iterations) and bias-corrected bootstrap confidence intervals (95%). The results are provided in Table 5.

The results showed that students' attitudes partially mediated the correlation between parental math beliefs and students' math achievement, as the indirect effects were statistically significant (β= 3.596, $p < 0.01$). However, students' attitudes did not mediate the correlation between parental math utility and math achievement (β = -0.111, $p > 0.05$). This result was expected, as no mediation can occur since parental math utility was insignificantly associated with math achievement as well as students' attitudes. Based on these results, H7 was accepted, while H6 was rejected.

Moderation of Family's SES

The TIMSS scale Home Resources for Learning was used for its possible moderation effect in this study.

Figure 10

Home Resources for Learning

Descriptive examination of the scale showed that a majority of three-quarters of the students had some resources at home (*SE* = 1.01), and in turn, the number of resources was positively correlated with the average math score. Students who had many resources at their disposal had an average score of 584 points (*SE* = 2.70), followed by an average of 531 points (*SE* = 2.03) for those students who had some resources, and students with only a few home resources reached an average of 485 points (*SE* = 8.34). Consequently, students with few resources had a math score of almost 100 points, or 17% less, than those students who had many resources at home.

For the moderation analysis of SES, two analyses were conducted. First, parental math beliefs were utilised as the independent variable with math achievement as the dependent variable and SES as moderator. For the analysis, interaction terms with the standardized scores of the variables were used (see Table 8). SES had a statistically significant, positive association (β= 0.026, *SE* = 0.010, $p < 0.05$) with the negative correlation between parental math beliefs and the students' math achievement. Thus, the SES dampened the correlation between the independent and dependent variable. As shown in Fig. 13, the graph is slightly steeper for low SES, which indicates that the association of parental math beliefs on students' math achievement was higher for students with a lower family SES than for those from a family of higher SES.

Figure 11

SES as Moderator Between Parental Math Beliefs and Math Achievement

Furthermore, the moderating effect of SES on the correlation of parental math utility and math achievement was analysed. Parental math utility was adopted as the independent variable and, as with parental beliefs, the dependent variable was fixed as math attitudes. In this case, a negative but not statistically significant correlation was seen, as shown in Table 6.

Consequently, H8 was supported (β= 0.026, *SE* = 0.010, $p < 0.05$), while H9 was rejected (β= -0.010, *SE* = 0.010, $p > 0.05$). Again, the rejection of H9 was expected due to the statistically insignificant association between parental math utility values and math achievement.

Discussion

The current study revealed that parental attitudes, beliefs, and expectations were mostly positive. Austrian parents had the impression that their children were talented in math, followed the lessons well, and enjoyed math. Furthermore, the parents saw math as important for their children's lives, specifically their future careers. However, while parental beliefs showed a negative correlation to their children's math achievement, parental utility value showed no significant correlation at all. For the mediation of students' attitudes, the hypothesis of a positive correlation with parental beliefs and achievement could be supported with the present results. Again, no significant correlation was seen between parental utility and students' attitudes. The moderation of SES showed a dampening effect on the existing negative parental beliefs-to-math attitudes correlation.

During the course of this study, several important observations were made, and although only some hypotheses could be confirmed, this research must be considered critically.

First, a closer insight into other forms of parental involvement, such as, support in homework or parental participation in school life, would have been useful to determine other possible mediating factors that could be related to the existing correlations. Moreover, an evaluation of older students would have provided additional insights. However, this evaluation was not possible due to the fact that home questionnaires were only administered to Grade 4 students, not Grade 8 students.

Secondly, the nature of this study – a secondary analysis – did not allow for additional questions and data that would have distinguished attitudes, beliefs, and expectations more visibly. This distinction would have been useful, as various definitions of parental attitudes exist in the literature of this field, which is a reason for diverging results. Despite this limitation, this study provides meaningful insights into the parent–child transmission of attitudes and possible consequences of parental attitudes, beliefs, and expectations for the students' math achievement, when taking mediating factors into consideration.

The results of the SEM raise questions about the implications for teachers and the Austrian education system. Parental attitudes, beliefs, and expectations are a topic that, at first glance, cannot be changed directly by the education sector. However, being aware of the role of attitudes towards math and their correlation to achievement is essential to support students and their learning in the best way possible (Dagdag & Bandera, 2021). Being informed about the correlation, teachers can begin interventions that help to reduce factors likely to negatively affect children's math achievement. While teachers have some possibilities to get parents more involved and increase their awareness of the importance of math and how to support their children concerning this subject, the more common interventions focus on the students, with whom teachers spend a lot of time.

As students' attitudes were positively correlated with math achievement, interventions fostering positive attitudes in children are of particular importance. While not directly working with students content-wise, Pinxten et al. (2014) stated that investing time and effort into making math lessons more attractive to students such that they enjoy learning math more is an indirect way of positively affecting math achievement. Hwang and Son (2021) mentioned five types of interventions teachers can take to foster positive attitudes towards math in students. First, engaging and motivating tasks can be implemented during math lessons. Second, diverse and innovative learning resources can foster positive attitudes. Third, feedback must be implemented correctly to boost confidence. Fourth, adequate difficulty levels should be identified by the teachers for students to succeed and not become overwhelmed. Finally, the value of math and its importance for the students' lives should be made evident. Which intervention(s) teachers implement depends on the class and even the individual student, which makes awareness of students' attitudes particularly important for teachers (Hwang & Son, 2021).

Berkowitz et al. (2015) identified positive effects in giving parents explicit instructions on how they should act with their children during math story problems. Their study included parents with particularly negative math attitudes – namely math anxiety –and an increase in math achievement of their elementary school children could be seen that was the same for children of parents without math anxiety. Consequently, giving parents guidance for the time they work with their child at home can help to block the transmission of negative attitudes and achievement-hindering behaviour. This support of parents is particularly important, as according to Šimunović and Babarović (2020), the parent's insecurities concerning STEM subjects can lead to a transmission of those feelings or not feeling competent to support their child with math work. Generally, parents should be educated about their role when it comes to children's math achievement by the educational sector – education also referred to as utility-value interventions (Šimunović & Babarović, 2020). Moreover, involving the parents in school projects linked to math is important, as was mentioned in the theory of overlapping spheres (Epstein & Sander, 2000). This involvement will not only help in parental education about the value of math but also help them become more involved (Šimunović et al., 2018).

One further method focuses on students as well as their parents, as it is aimed at working against stereotypical thoughts on STEM domains. Although Austrian parents and students showed positive attitudes towards math, these must be supported, and existing stereotypes must be worked against. Many parents and students do not have sufficient knowledge concerning possible future careers in STEM domains, which fosters stereotypical images of the people working in such jobs (Archer et al., 2014). Archer et al. (2014) – although acknowledging the fact that science and math events and meetings with people working in different STEM domains can have positive effects – stated that it is not enough to positively portray career paths in math; rather, a long-term intervention must be taken. They suggested fostering positive math attitudes in schools from an early age on, even starting in elementary school. Furthermore, parents should be educated and included in such interventions, with a focus on families with lower SES, as those have fewer available resources and moderation indicates a positive effect of more available at-home resources (Archer et al., 2014).

Furthermore, as SES was found to be a dampening moderator for the negative correlation between parental beliefs and math achievement, providing students from lower SES families with at-home learning resources could be beneficial. Following Bourdieu's theory of cultural capital (1986), giving students objectified cultural capital – which, according to several studies, also shows a direct positive correlation to achievement – can be an option to support children from lower SES (Tan, 2017). As objectified cultural capital is the only form of cultural capital the educational sector can directly influence, this should be given special attention (Xie & Hutagalung, 2025).

Lastly, a study of Asia-Pacific students in TIMSS 2023 (AlMamari, 2026) found that gender, migration status and family background did not operate uniformly, but are shaped by regional opportunity, structures and educational environments. The findings from the current study, while limited to Austrian TIMSS 2019 data, ultimately argues that the theory of

overlapping spheres by Epstein (1992) should be considered when formulating ways to support students in their math achievement in light of parental attitudes, beliefs, and expectations. Based on this theory, including all three parties – family, school, and community – will reduce the sole responsibility and pressure from parents, and creating joined and transparent goals will make supporting students in their math achievement easier across opportunities, structures and educational environments (Epstein & Sander, 2000).

Declarations

Availability of data and materials

The data that support the findings of this study are available from the Institut des Bundes für Qualitätssicherung im österreichischen Schulwesen but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data re however available from the authors upon reasonable request and with permission of the Institut des Bundes für Qualitätssicherung im österreichischen Schulwesen

Competing interests

The authors declare that they have no competing interests.

Author contributions

Author 1: Conceptualisation, data curation, formal analysis, visualisation

Author 2: Writing original draft, review and editing

References

1. Alami, M. (2016). Causes of poor academic performance among Omani students. *International Journal of Social Science Research*, *4*(1), 126-136. doi:10.5296/ijssr.v4i1.8948
2. Alavi, M., Visentin, D. C., Thapa, D. K., Hunt, G. E., Watson, R., & Cleary, M. (2020). Chi-square for model fit in confirmatory factor analysis. *Journal of advanced nursing*, *76*(9), 2209-2211. **https://doi.org/10.1111/jan.14399**
3. ALMamari, K. (2026). Parental education, home resources, gender, and academic achievement: a multilevel analysis of GCC and Asia–Pacific students in TIMSS 2023. *Large-scale Assessments in Education*, *14*(1), 13. https://doi.org/10.1186/s40536-026-00279-w
4. Archer, L., DeWitt, J., & Dillon, J. (2014). 'It didn't really change my opinion': Exploring what works, what doesn't and why in a school science, technology, engineering, and mathematics careers intervention. *Research in Science & Technological Education*, *32*(1), 35–55. https://doi.org/10.1080/02635143.2013.865601
5. Bah, Y.M. (2021). Poor performance in mathematics among senior secondary school students: Lessons for education planners and parents. *International Journal of Education & Literature*, *7*(11), 10-19.https://www.researchgate.net/publication/360143158_Poor_performance_in_mathematics_among_senior_secondary_school_students_Lessons_for_education_planners_and_parents
6. Baharum, H., Awang, Z., Ismali, A., & McKenna, L. (2023). The study adapted instruments based on confirmatory factor analysis (CFA) to validate measurement models of latent constructs. *International Journal of Environmental Research and Public Health*, 20, 1-16.https://doi.org/10.3390/ ijerph20042860
7. Barger, M. M., Wu, J., Xiong, Y., Oh, D. D., Cimpian, A., & Pomerantz, E. M. (2022). Parents' responses to children's math performance in early elementary school: Links with parents' math beliefs and children's math adjustment. *Child Development*, *93*(6), 639-655. https://doi.org/10.1111/cdev.13834

8. Berkowitz, T., Schaeffer, M. W., Maloney, E. A., Peterson, L., Gregor, C., Levine, S. C., & Beilock, S. L. (2015). Math at home adds up to achievement in school. *Science*, *350*(6257), 196–198. https://doi.org/10.1126/science.aac7427
9. Casad, B. J., Hale, P., & Wachs, F. L. (2015). Parent-child math anxiety and math-gender stereotypes predict adolescents' math education outcomes. *Frontiers in Psychology*, *6*, 1-21.https://doi.org/10.3389/fpsyg.2015.01597
10. Chen, X. Zhou, J., Li, D., Liu, J. Dai, Y., & Zhou, T. (2022). Enjoyment of Chinese and mathematics and school performance in Chinese children and adolescents. *Child Development*, *94*, 126-141. DOI: 10.1111/cdev.13843
11. Cheung, G.W., Cooper-Thomas, H.D., Lau, R.S., & Wang, L.C. (2023). Reporting reliability, convergent and discriminant validity with structural equation modeling: A review and best-practice recommendations. *Asia Pacific Journal of Management*, *41*, 745-783. https://doi.org/10.1007/s10490-023-09871-y
12. Conger, R. D., & Donnellan, M. B. (2006). An interactionist perspective on the socioeconomic context of human development. *Annual Review of Psychology*, *58*(1), 175–199. DOI: 10.1146/annurev.psych.58.110405.085551
13. Cvencek, D., Brečic, R., Gaćeša, D., & Meltzoff, A. N. (2021) Development of math attitudes and math self-concepts: Gender differences, implicit–explicit dissociations, and relations to math achievement. *Child Development*, *92*(5), 940-956. https://doi.org/10.1111/cdev.13523
14. Dagdag, J. D., & Bandera, M. M. D. (2021). Understanding the factors that influence students' behavior: Key towards effective teaching. *Pedagogi Jurnal Ilmu Pendidikan*, *21*(2), 144– 148. https://doi.org/10.24036/pedagogi.v21i2.1182
15. Davadas, S. D., & Lay, Y. F. (2017). Factors affecting students' attitude toward mathematics: A structural equation modeling approach. *Eurasia Journal of Mathematics Science and Technology Education*, *14*(1), 517-529. https://doi.org/10.12973/ejmste/80356
16. Ding, F., Xiao, X., Shi, Y., Wan, Y., & Cheng, G. (2022). Parental attitudes toward school and Chinese adolescents' academic performance: A moderated mediation model. *School Psychology International*, *43*(2), 178–195. DOI: 10.1177/01430343221077249
17. Dowker, A., Cheriton, O., Horton, R., & Mark, W. (2019). Relationships between attitudes and performance in young children's mathematics. *Education Studies in Mathematics*, *100*, 211-230. https://doi.org/10.1007/s10649-019-9880-5
18. Duncan, L. G., Coatsworth, J. D., Gayles, J. G., Geier, M. H., & Greenberg, M. T. (2015). Can mindful parenting be observed? Relations between observational ratings of mother–youth interactions and mothers' self-report of mindful parenting. *Journal of Family Psychology*, *29*(2), 276. https://doi.org/10.1037/a0038857
19. Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology*, *53*(1), 109–132. https://doi.org/10.1146/annurev.psych.53.100901.135153
20. Epstein, J.L. (1992). *School and family partnership. Report No. 6.* Center on Families, Communities, Schools & Children's Learning. https://eric.ed.gov/?id=ED343715
21. Epstein, J. L., & Sanders, M. G. (2000). Connecting home, school, and community: New directions for social research. In M. Hallinan (Ed.), *Handbook of sociology of education* (pp. 285–306). Springer.
22. European Commission. (2025, March 3). *A STEM Education Strategic Plan: skills for competitiveness and innovation*. https://www.nationalesmintforum.de/newsroom/detail/einordnung-kommentar-des-nationalen-mint-forums-zum-stem-education-strategic-plan-der-eu- kommission
23. Evans, D., & Field, A.P. (2020). Math attitudes, school affect and teacher characteristics as predictors of math attainment trajectories in primary and secondary education. *Royal Society Open Science, 7*, 1-25. http://dx.doi.org/10.1098/rsos.200975
24. Fan, X., & Chen, M. (2001). Parental involvement and students' academic achievement: A meta-analysis. *Educational Psychology Review*, *13*(1), 1-22. https://www.jstor.org/stable/23358867

25. Fishbein, B., Foy, P., & Yin, L. (2021). *TIMSS 2019 User Guide for the International Database (2nd Edition)*. IEA TIMSS & PIRLS International Study Center, Boston College. https://timss2019.org/international-database/
26. Fodouop Kouam, A.W. (2024). Assimilating mediating and moderating variables in academic research: Role and significance. *International Journal of Research Publications*, *143* (1), 273-278. DOI: 10.47119/IJRP1001431220246119
27. Garon-Carrier, G., Boivin, M., Lemelin, J., Kovas, Y., Parent, S., Séguin, J.R., Vitaro, F., Tremblay, R.E., & Dionne, G. (2018). Early developmental trajectories of number knowledge and math achievement from 4 to 10 years: Low-persistent profile and early life predictors. *Journal of School Psychology*, *68*, 84–98. https://doi.org/10.1016/j.jsp.2018.02.004
28. Geary, D. (2011). Consequences, characteristics, and causes of mathematical learning disabilities and persistent low achievement in mathematics. *Journal of developmental and behavioral pediatrics*, *32*(3), 250-263. DOI: 10.1097/DBP.0b013e318209edef
29. Ghanad, A. (2023). An overview of quantitative research methods. *International Journal of Multidisciplinary Research and Analysis*, *6*(8), 3794-3803. DOI: 10.47191/ijmra/v6-i8-52
30. Goretzko, D., Siemund, K., & Sterner, P. (2024). Evaluating model fit of measurement models in confirmatory factor analysis. *Educational and Psychological Measurement*, *84*(1), 123–144. https://doi.org/10.1177/00131644231163813
31. Group Gordon, Inc. (2017, April 18). Math and science are kids' favorite subjects, but parents value reading and writing skills more, according to new study. *GlobeNewswire News Room* https://www.globenewswire.com/news-release/2017/04/18/988983/0/en/Math-and-Science-are-Kids-Favorite-Subjects-But-Parents-Value-Reading-and-Writing-Skills-More-According-to-New-Study.html
32. Gunderson, E. A., Ramirez, G., Levine, S. C., & Beilock, S. L. (2011). The role of parents and teachers in the development of gender-related math attitudes. *Sex Roles*, *66*(3–4), 153–166. https://doi.org/10.1007/s11199-011-9996-2
33. Hällsten, M., & Thaning, M. (2021). Wealth as one of the "Big four" SES dimensions in intergenerational transmissions. *Social Forces*, *100*(4), 1533–1560. https://doi.org/10.1093/sf/soab080
34. Harris, J.E., & Gleason, P.M. (2022). Application of path analysis and structural equation modeling in nutrition and dietetics. *Journal of the Academy of Nutrition and Dietetics*, *122*(11), 2023- 2035. https://doi.org/10.1016/j.jand.2022.07.007
35. Harun, Kartowagiran, B., & Manaf, A. (2021). Student attitude and mathematics learning success: A meta-analysis. *International Journal of Instruction*, *14*(4), 209-222. https://doi.org/10.29333/iji.2021.14413a
36. Hascoet, M., Giaconi, V., & Jamain, L. (2021). Family socioeconomic status and parental expectations affect mathematics achievement in a national sample of Chilean students. Zave*International Journal of Behavioral Development*, *45*(2), 122-132. https://doi.org/10.1177/0165025420965731
37. Heppt, B., Olczyk, M., & Volodina, A. (2022). Number of books at home as an indicator of socioeconomic status: Examining its extensions and their incremental validity for academic achievement. *Social Psychology of Education*, *25*, 903–928. https://doi.org/10.1007/s11218-022-09704-8
38. Hunter, J. (2021). An intersection of mathematics educational values and cultural values: Pasifika students' understanding and explanation of their mathematics educational values. *ECNU Review of Education*, *4*(2), 307-326. DOI: 10.1177/2096531120931106
39. Hwang, S., & Son, T. (2021). Students' attitude toward mathematics and its relationship with mathematics achievement. *Journal of Education and e-Learning Research*, *8*(3), 272–280. https://doi.org/10.20448/journal.509.2021.83.272.280

40. IEA TIMSS & PIRLS. (n.d.). *TIMSS 2019 International Database*. https://timss2019.org/international-database/
41. Institut des Bundes für Qualitätssicherung im österreichischen Schulwesen. (n.d.-a.). *TIMSS 2019*. https://www.iqs.gv.at/timss-2019
42. Itzlinger-Bruneforth, U. (Ed.). (2020). *TIMSS 2019. Studienübersicht*. Institut des Bundes für Qualitätssicherung im österreichischen Schulwesen. https://www.iqs.gv.at/downloads/internationale-studien/timss/timss-2019
43. Jansen, M., Scherer, R., & Schroeders, U. (2015). Students' self-concept and self-efficacy in the sciences: Differential relations to antecedents and educational outcomes. *Contemporary educational psychology*, *41*, 13-24.
44. Kang, H., & Ahn, J. (2021). Model setting and interpretation of results in research using structural equation modeling: A checklist with guiding questions for reporting. *Asian Nursing Research*, *15*, 157-162. https://doi.org/10.1016/j.anr.2021.06.001
45. Kelty, N. E., & Wakabayashi, T. (2020). Family engagement in schools: parent, educator, and community perspectives. *SAGE Open*, *10*(4), 1-13. https://doi.org/10.1177/2158244020973024
46. Kilic, S., & Askin, Ö. E. (2013). Parental influence on students' mathematics achievement: The comparative study of Turkey and best performer countries in TIMSS 2011. *Procedia - Social and Behavioral Sciences*, *106*, 2000–2007. https://doi.org/10.1016/j.sbspro.2013.12.228
47. Kobra, M. K., Uddin, M. E., Wahab, G. M. A., & Kabir, M. A. (2024). Socioeconomic status and children's math proficiency development: The role of parental math expectation, investment, and involvement. *International Journal of Research and Innovation in Social Science*, *VIII*(IV), 1333–1344.https://doi.org/10.47772/ijriss.2024.804099
48. MacKinnon, D. P. (2011). Integrating mediators and moderators in research design. *Research on Social Work Practice*, *21*(6), 675-681. https://doi.org/10.1177/1049731511414148
49. Markovits, Z., & Forgasz, H. (2017). 'Mathematics is like a lion': Elementary students' beliefs about mathematics. *Educ Stud Math*, *96*, 49-64. DOI: 10.1007/s10649-017-9759-2
50. Marsh, H. W., Pekrun, R., Guo, J., Hattie, J., & Karin, E. (2023). Too much of a good thing might be bad: The double-edged sword of parental aspirations and the adverse effects of aspiration-expectation gaps. *Educational Psychology Review*, *35*(49), 1-45. https://doi.org/10.1007/s10648-023-09768-8
51. Martin, M. O., Mullis, I. V. S., & Foy, P. (2017). TIMSS 2019 Assessment Design. In I. V. S. Mullis & M. O. Martin (Eds.), *TIMSS 2019 Assessment Frameworks* (pp. 79–92). TIMSS & PIRLS International Study Center, Boston College. http://timssandpirls.bc.edu/timss2019/frameworks/
52. Mohr-Schroeder, M. J., Jackson, C., Cavalcanti, M., Jong, C., Schroeder, D. C., & Speler, L. G. (2017). Parents' attitudes toward mathematics and the influence on their students' attitudes toward mathematics: A quantitative study. *School Science And Mathematics*, *117*(5), 214–222. https://doi.org/10.1111/ssm.12225
53. Mullis, I.V.S., Martin, M.O., Foy, P., Kelly, D.L., & Fishbein, B. (2020). *TIMSS 2019 International Results in Mathematics and Science.* TIMSS & PIRLS International Study Center, Boston College. https://timssandpirls.bc.edu/timss2019/international-results/
54. Myrberg, E., & Rosén, M. (2008). A path model with mediating factors of parents' education on students' reading achievement in seven countries. *Educational Research and Evaluation*, *14*(6), 507–520. https://doi.org/10.1080/13803610802576742
55. Myrberg, E., & Rosén, M. (2009). Direct and indirect effects of parents' education on reading achievement among third graders in Sweden. *British Journal of Educational Psychology*, *79*(4), 695–711.https://doi.org/10.1348/000709909x453031
56. Nalipay, M. J. N., Cai, Y., & King, R. B. (2021). The social contagion of utility value: How parents' beliefs about the usefulness of science predict their children's motivation and achievement. *School Psychology International*, *42*(3), 221–237. https://doi.org/10.1177/0143034320985200

57. OECD (2023). *PISA 2022 Results (Volume I): The State of Learning and Equity in Education*, OECD Publishing.https://doi.org/10.1787/53f23881-en
58. Orcan, F. (2018). Exploratory and confirmatory factor analysis: Which one to use first? *Eğitimde Ve Psikolojide Ölçme Ve Değerlendirme Dergisi*, *9*(4), 414–421. https://doi.org/10.21031/epod.394323
59. Østbø, I. U., & Zachrisson, H. D. (2021). Student motivation and parental attitude as mediators for SES effects on mathematics achievement: Evidence from Norway in TIMSS 2015. *Scandinavian Journal of Educational Research*, *66*(5), 808–823. https://doi.org/10.1080/00313831.2021.1939138
60. Pan, Y., Yang, Q., Li, Y., Liu, L., & Liu, S. (2018). Effects of family socioeconomic status on home math activities in urban China: The role of parental beliefs. *Children and Youth Services Review*, *93*, 60–68. https://doi.org/10.1016/j.childyouth.2018.07.006
61. Peixoto, F., Mata, L., Campos, M., Caetano, T., Radišić, J., & Niemivirta, M. (2023). 'Am I to blame because my child is not motivated to do math?': Relationships between parents' attitudes, beliefs and practices towards mathematics and students' mathematics motivation and achievement. *European Journal of Psychology of Education*, *39*(2), 1561–1586. https://doi.org/10.1007/s10212-023-00774-6
62. Peña, D. C. (2000). Parent involvement: Influencing factors and implications. *The Journal of Educational Research*, *94*(1), 42–54. https://doi.org/10.1080/00220670009598741
63. Philipp, A. (2007). Mathematics teachers' beliefs and affect. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp.257-315). National Council of Teachers of Mathematics.https://www.researchgate.net/publication/284039669_Mathematics_teachers%27_beliefs_and_affect
64. Pinxten, M., Marsh, H. W., De Fraine, B., Van Den Noortgate, W., & Van Damme, J. (2014). Enjoying mathematics or feeling competent in mathematics? Reciprocal effects on mathematics achievement and perceived math effort expenditure. *British Journal of Educational Psychology*, *84*(1), 152–174. https://doi.org/10.1111/bjep.12028
65. Rodríguez, S., Piñeiro, I., Gómez-Taibo, M. L., Regueiro, B., Estévez, I., & Valle, A. (2017). An explanatory model of maths achievement: Perceived parental involvement and academic motivation. *Psicothema*, *29*(2), 184-190. DOI: 10.7334/psicothema2017.32
66. Rowan-Kenyon, H.T., Swan, A.K., & Creager, M.F. (2012). Social cognitive factors, support, and engagement: Early adolescents' math interests as precursors to choice of career. *The Career Development Quarterly*, *60*, 1-15.https://doi.org/10.1002/j.2161-0045.2012.00001.x
67. Santos, P. M. D., & Cirillo, M. Â. (2021). Construction of the average variance extracted index for construct validation in structural equation models with adaptive regressions. *Communications in Statistics Simulation and Computation*, *52*(4), 1639–1650. https://doi.org/10.1080/03610918.2021.1888122
68. Sardeshmukh, S., & Vandenberg, R. J. (2017). Integrating moderation and mediation: a structural equation modeling approach. *Organizational Research Methods, 20*(4), 721-745. DOI: 10.1177/1094428115621609
69. Sathyanarayana, S., & Mohanasundaram, T. (2025). Mediation analysis in structural equation modeling (SEM): Theoretical foundations, statistical methods and practical implications. *Asian Journal of Economics Business and Accounting*, *25*(3), 19–37. https://doi.org/10.9734/ajeba/2025/v25i31692
70. Schermelleh-Engel, K., & Moosbrugger, H. (2003). Evaluating the fit of structural equation models: Test of significance and descriptive goodness-of-fit measure. *Methods of Psychological Research Online*, *8*(2), 23-74. https://www.researchgate.net/publication/251060246_Evaluating_the_Fit_of_Structural_Equation_Models_Tests_of_Significance_and_Descriptive_Goodness-of-Fit_Measures
71. Shapira-Lishchinsky, O., & Zavelevsky, E. (2019). Multiple appearances of parental interactions and math achievement on TIMSS international assessment. *International Journal of Science and Mathematics Education*, *18*(1), 145–161. https://doi.org/10.1007/s10763-018- 09949-w

72. Silver, A. M., Elliott, L., & Libertus, M. E. (2021). When beliefs matter most: Examining children's math achievement in the context of parental math anxiety. *Journal of Experimental Child Psychology*, *201*, 1-27. https://doi.org/10.1016/j.jecp.2020.104992
73. Simcox, J.A. (2018). Problems with the use of Cronbach's Alpha as a test of scale reliability for social science surveys. *International Journal of Social Science and Humanities Research, 6(2)*, 225-229. https://www.researchpublish.com/upload/book/Problems%20with%20the%20Use%20of%20Chronbach-5654.pdf
74. Šimunović, M., & Babarović, T. (2020). The role of parents' beliefs in students' motivation, achievement, and choices in the STEM domain: a review and directions for future research. *Social Psychology of Education*, *23*, 701-719. https://doi.org/10.1007/s11218-020-09555-1
75. Šimunović, M., Ercegovac, I. R., & Burušić, J. (2018). How important is it to my parents? Transmission of STEM academic values: the role of parents' values and practices and children's perceptions of parental influences. *International Journal of Science Education*, *40*(9), 977–995. https://doi.org/10.1080/09500693.2018.1460696
76. Stamm, M. (2021). *Psychologie der Elternerwartungen. Warum zu hohe Erwartungen den kindlichen Schulerfolg beeinträchtigen können*. Swiss Education.https://www.zh.ch/content/dam/zhweb/bilder-dokumente/themen/familie/angebote-fuer-familien-mit-kindern/elternbildung/newsletter/ausgabe-juli-2021/dossier_elternerwartungen_stamm.pdf
77. Uscianowski, C., Almeda, M. V., & Ginsburg, H. P. (2020). Differences in the complexity of math and literacy questions parents pose during storybook reading. *Early Childhood Research Quarterly*, *50*, 40-50. https://doi.org/10.1016/j.ecresq.2018.07.003
78. Usher, E.L. (2009). Sources of middle school students' self-efficacy in mathematics: A qualitative investigation. *American Educational Research Association*, *46*(1), 275-314. https://www.jstor.org/stable/27667179
79. Weerasinghe, D. (2016, July 19-22). *A mixed methods design to investigate student outcomes based on parental attitudes, beliefs, and expectations in mathematics education*. ACSPRI Social Science Methodology Conference 2016, University of Sydney, https://www.researchgate.net/publication/306424427_A_mixed_methods_design_to_investigate_student_outcomes_based_on_parental_attitudes_beliefs_and_expectations_in_mathematics_education
80. Wang, G.G. (2014). Understanding the indigenous Chinese concept of suzhi (□□) from an HRM perspective. *Journal of Chinese Human Resource Management*, *5*(2), 98–114. DOI: 10.1108/JCHRM-08-2014-0027
81. Wen, R., & Dubé, A.K. (2022). A systematic review of secondary students' attitudes towards mathematics and its relations with mathematics achievement. *Journal of Numerical Cognition*, 8(2), 295-325. https://doi.org/10.5964/jnc.7937
82. Xie, F., & Hutagalung, F. D. (2025). How does cultural capital influence academic achievement in the Chinese context? A systematic literature review. *SAGE Open*, *15*(1), 1-20. https://doi.org/10.1177/21582440251315980
83. Yin, L. & Fishbein, B. (2020). Creating and interpreting the TIMSS 2019 context questionnaire scales. In M. O. Martin, M. von Davier & I.V.S. Mullis (Eds.), *Methods and Procedures: TIMSS 2019 Technical Report* (pp. 16.1-16.331). TIMSS & PIRLS International Study Center. https://timssandpirls.bc.edu/timss2019/methods
84. Zakariya, Y. F. (2022). Cronbach's alpha in mathematics education research: Its appropriateness, overuse, and alternatives in estimating scale reliability. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.1074430
85. Zhang, Q. (2019). Values in mathematics learning: Perspectives of Chinese mainland primary and secondary students. In P. Clarkson, W.T. Seah & J. Pang (Eds.), *Values and Valuing in Mathematics Education. Scanning and Scoping Territory* (pp. 185-196). Springer. https://doi.org/10.1007/978-3-030-16892-6

Footnotes

1. For the sake of this study, students main care givers are referred to as “parents” in this study. This is based on the Austrian TIMSS 2019 home questionnaire, which is labelled *Elternfragebogen*, and literature referring to parental involvement regarding correlations between care givers and students’ achievement.

Tables

Tables 1 to 6 are available in the Supplementary Files section.

Figures

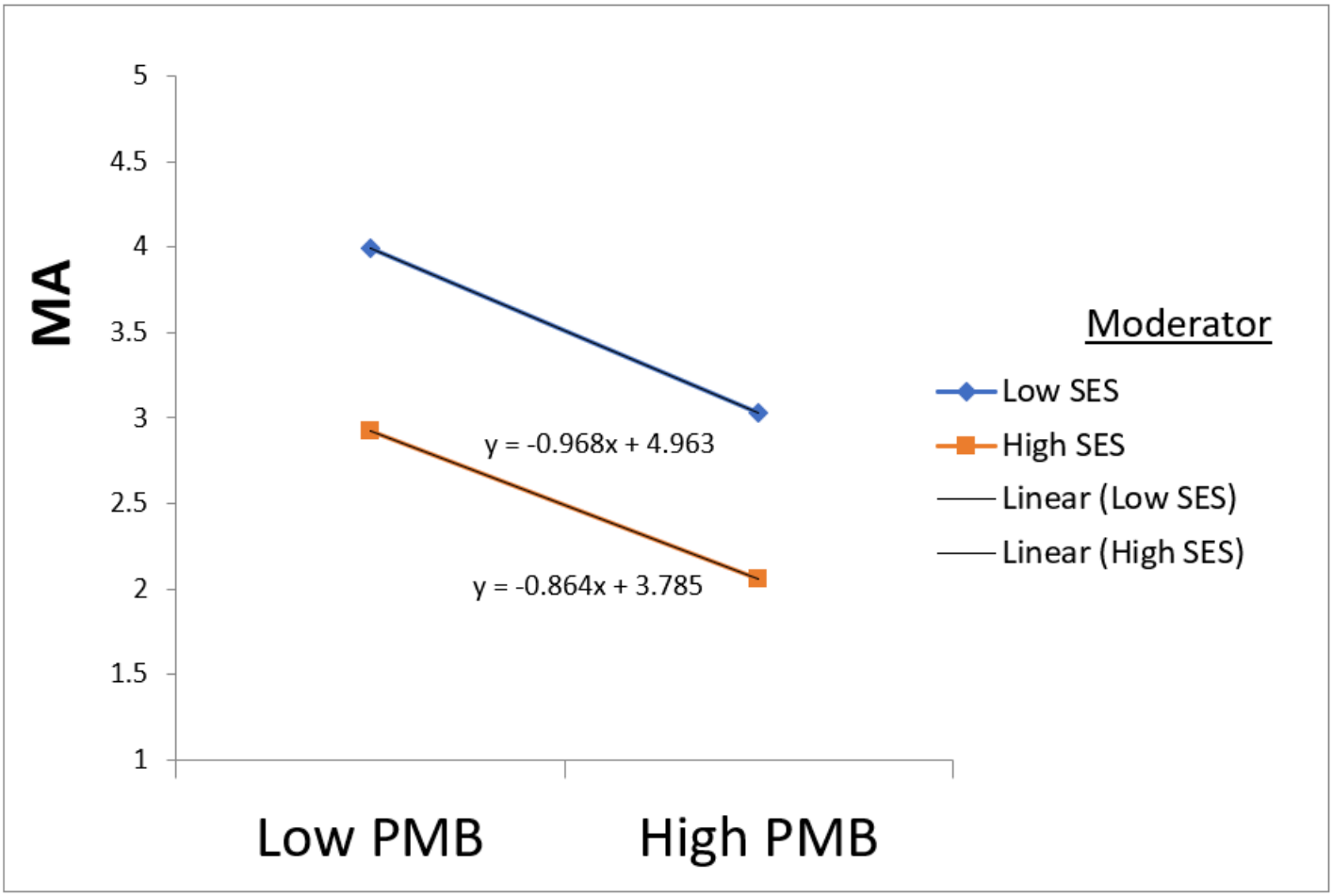


Figure 1

Hypothetical Model by Ding et al, 2022:182

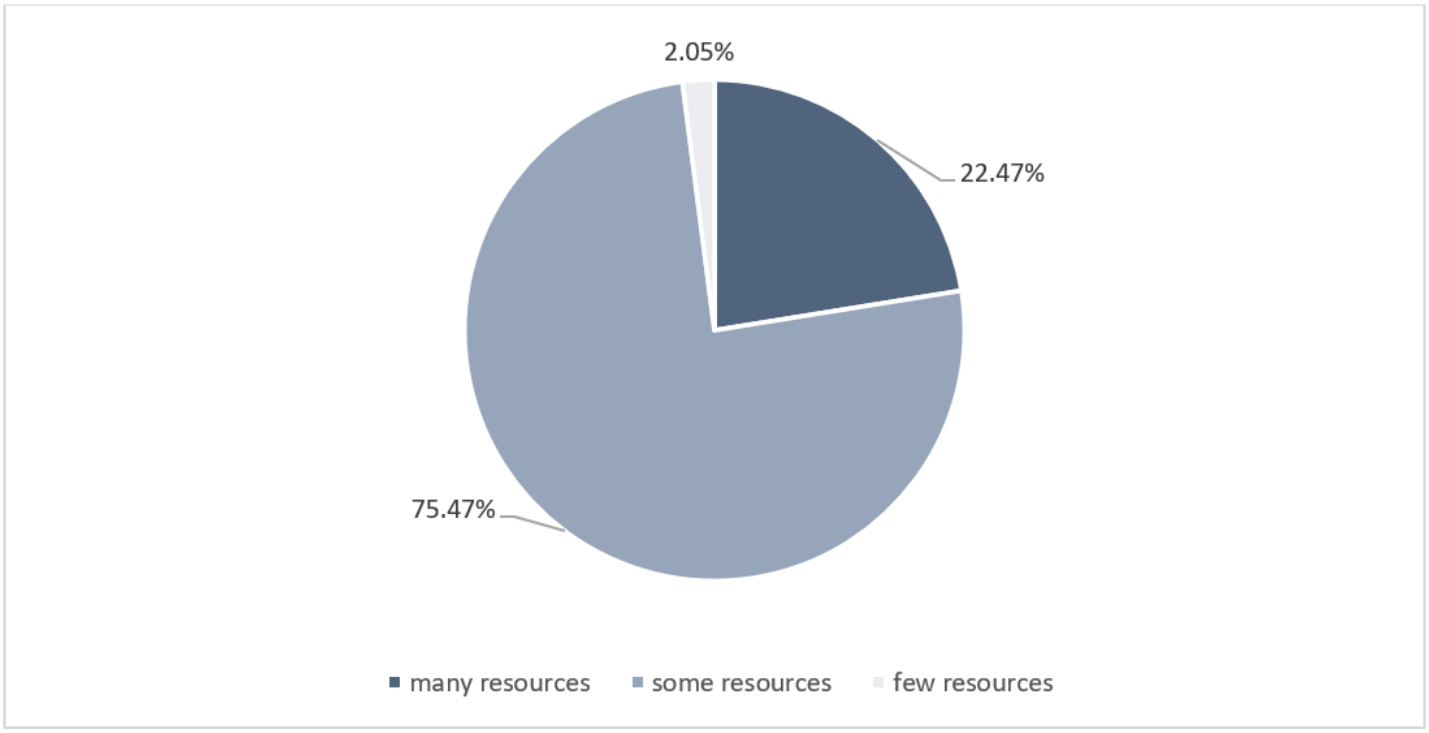


Figure 2

SEM with Hypotheses

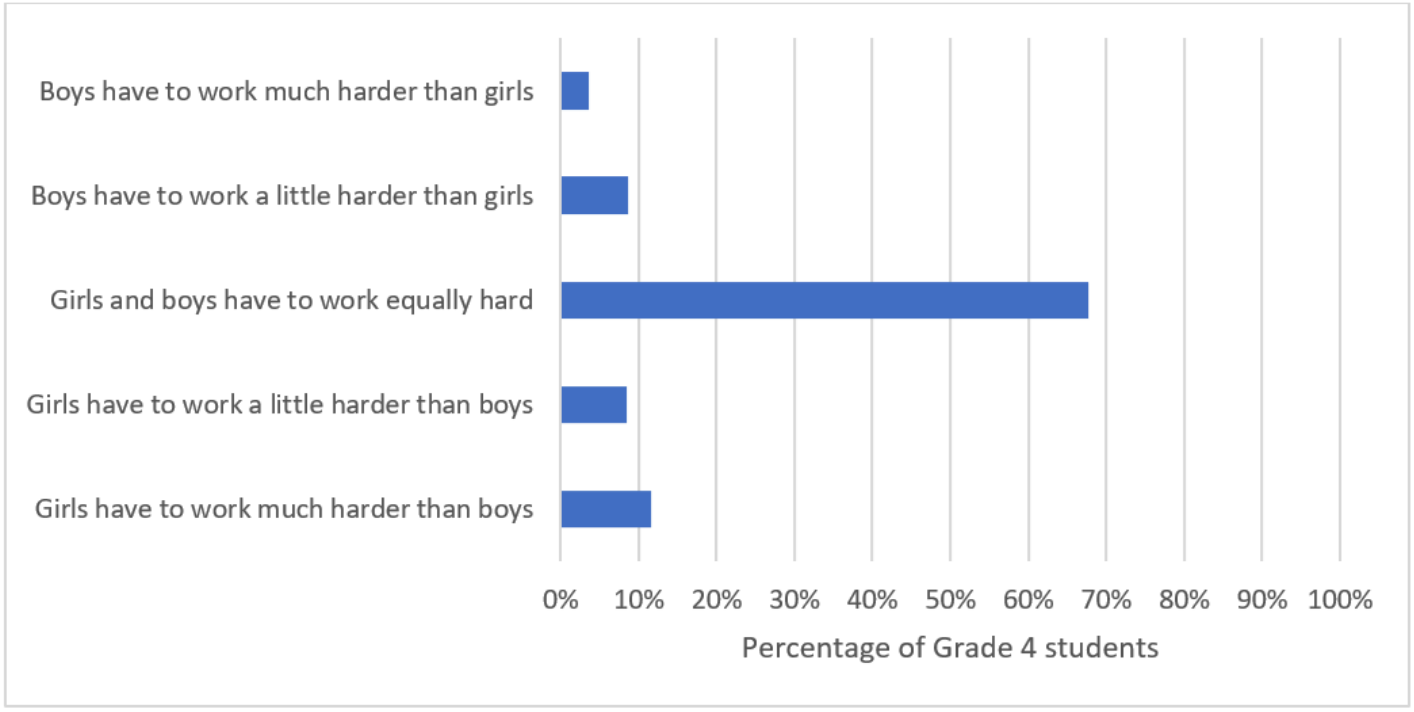


Figure 3

Parent Math Utility Attitudes

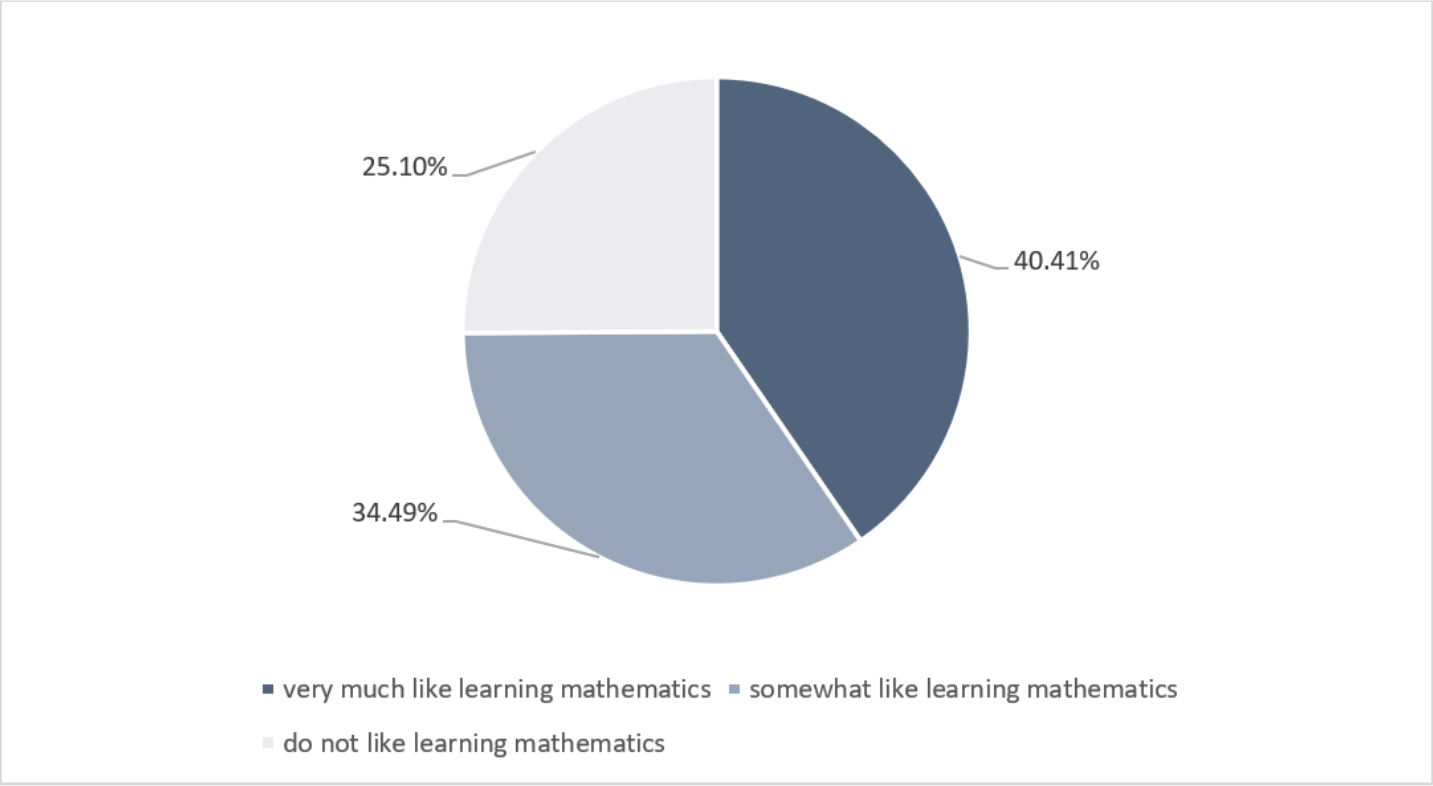
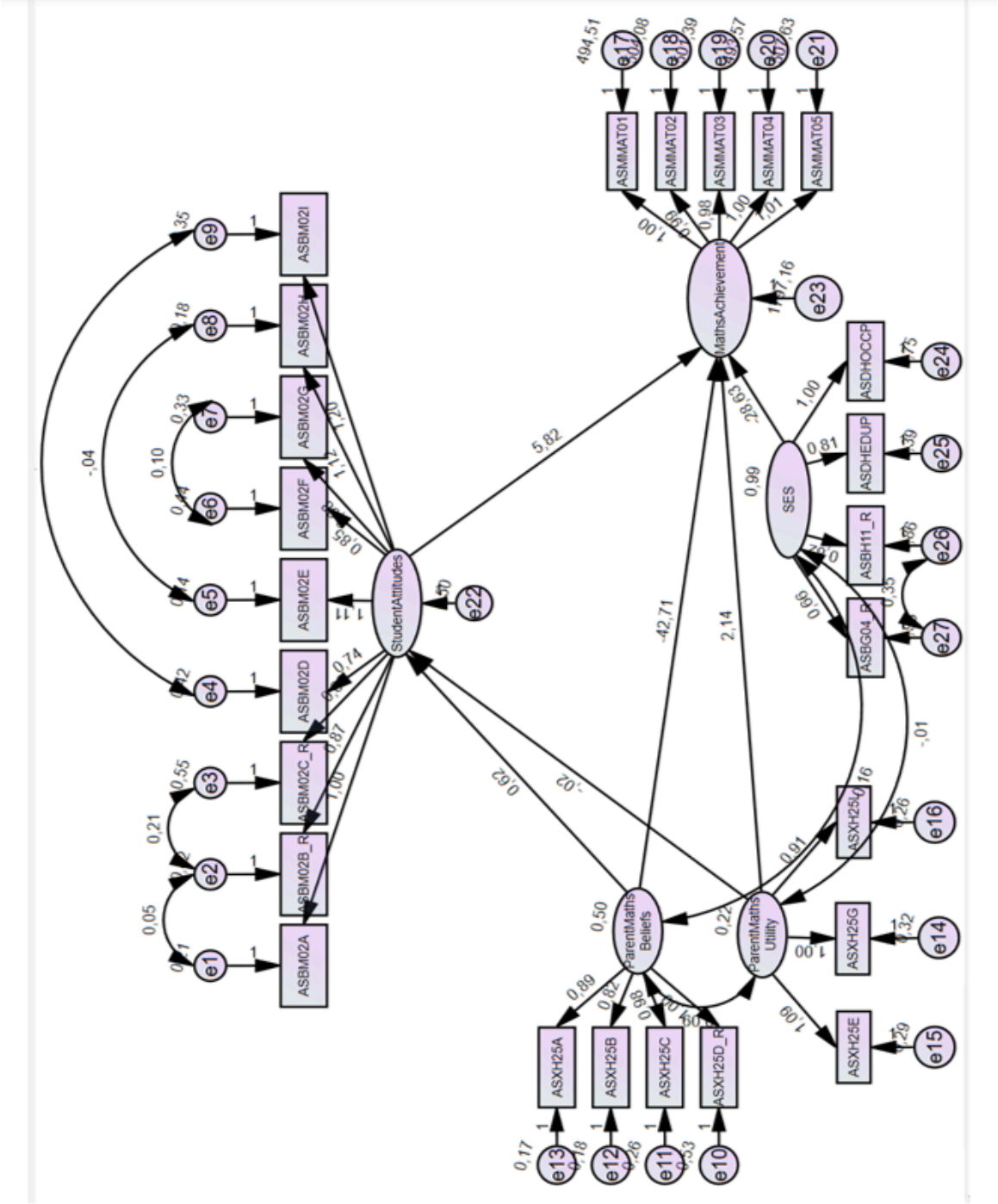


Figure 4

Parental Math Beliefs Concerning Their Child's Relationship to Math


ASBM02I
ASBM02H
ASBM02G
ASBM02F
ASBM02E
ASBM02D
ASBM02C_R
ASBM02B_R
ASBM02A
StudentAttitudes
ASMMAT01
ASMMAT02
ASMMAT03
ASMMAT04
ASMMAT05
MathsAchievement
ASDHOCCP
ASDHEDUP
SES
ASBH11_R
ASBG04_R
ASXH25A
ASXH25B
ASXH25C
ASXH25D_R
ParentMaths Beliefs
ASXH25G
ASXH25E
ParentMaths Utility
5,82
-42,71
2,14
0,62
-,02
-,01
0,91
0,50
0,22
0,99
0,81
1,00
0,89
0,87
0,98
0,60
1,00
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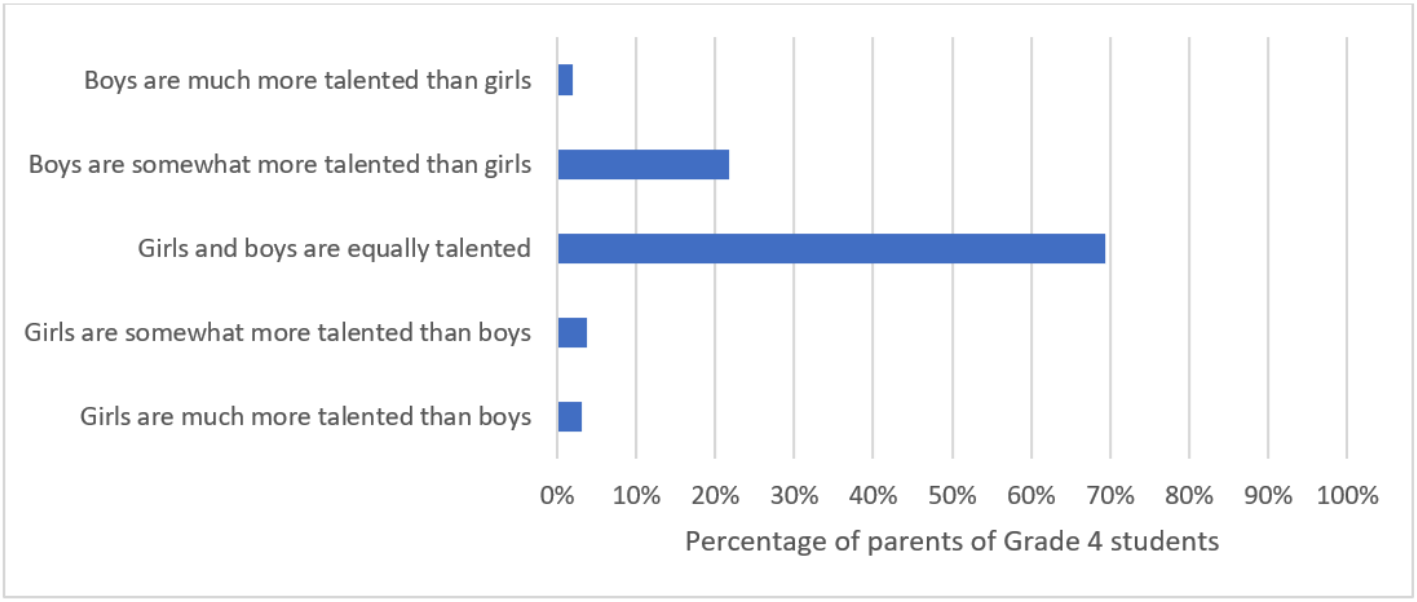


Figure 6

Parental Gender Beliefs

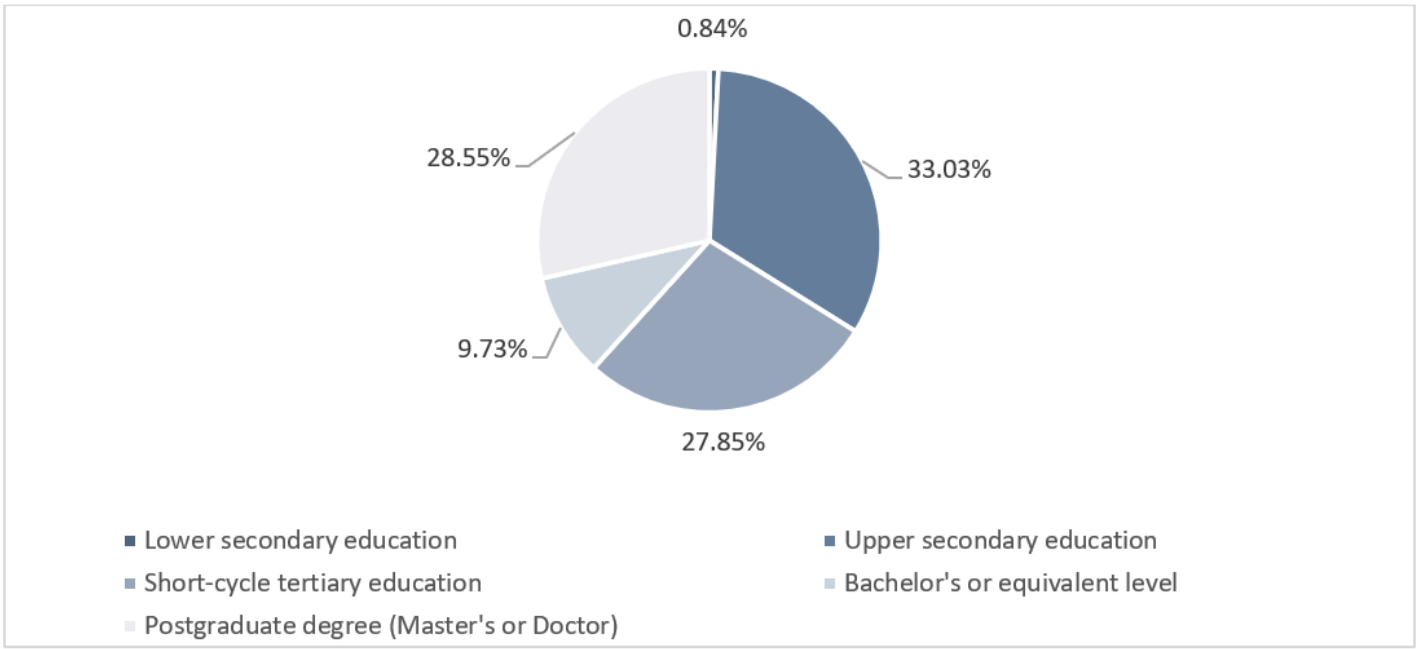


Figure 7

EM with Path Coefficients

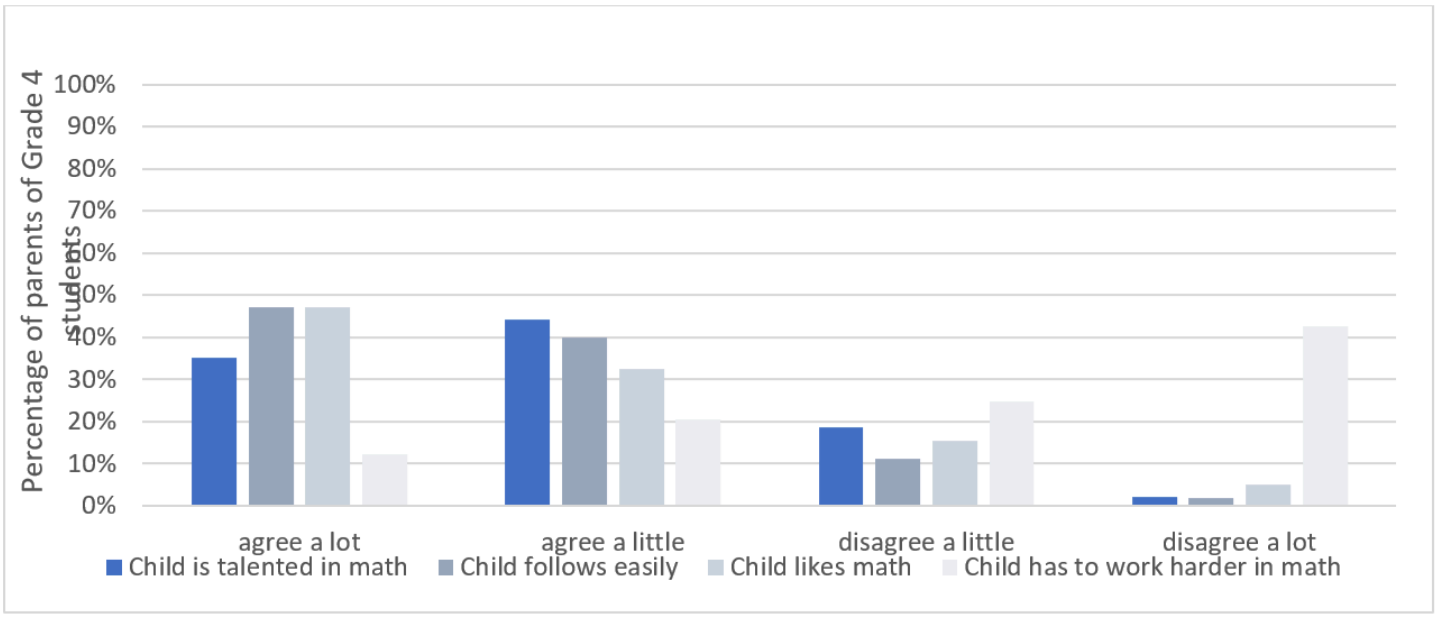


Figure 8

Students' Attitudes Towards Math

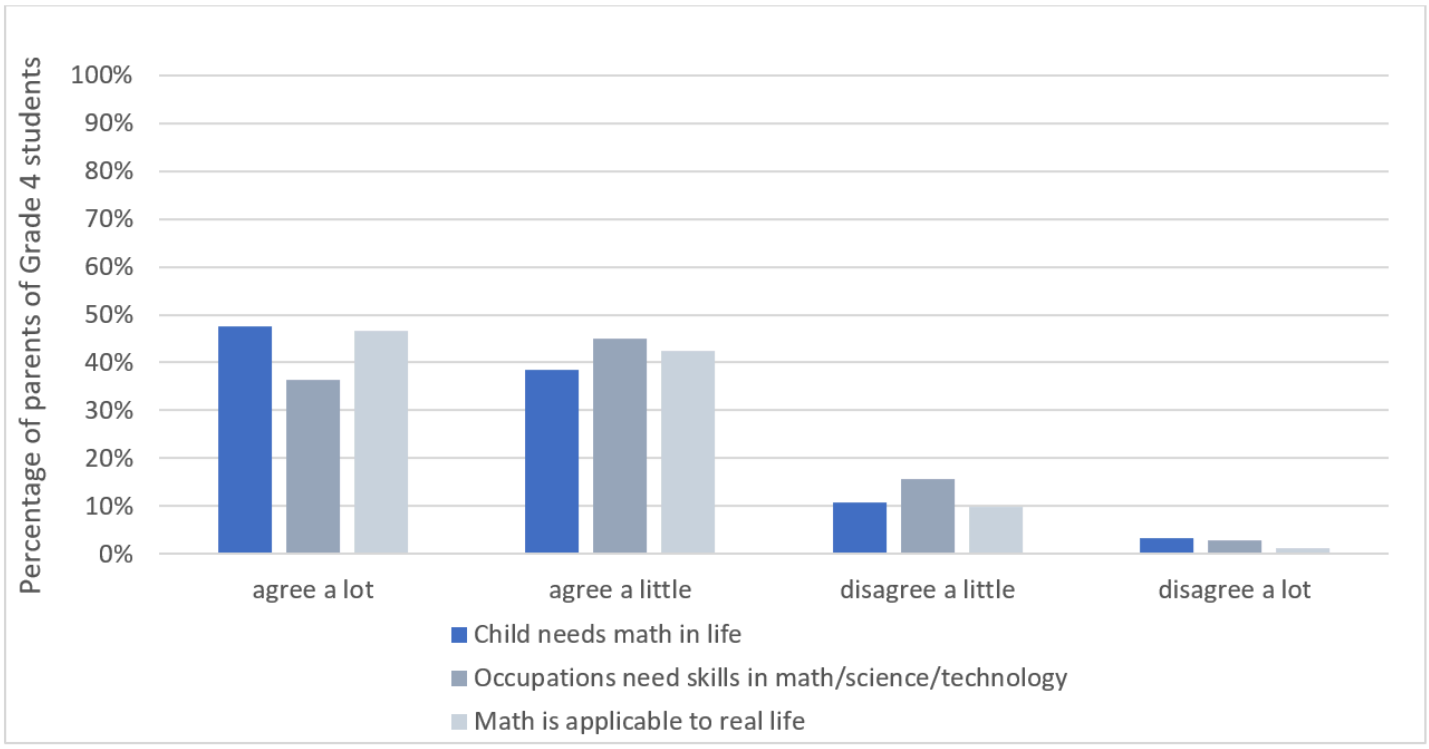


Figure 9

Students' Gender Expectations



Figure 10

Home Resources for Learning

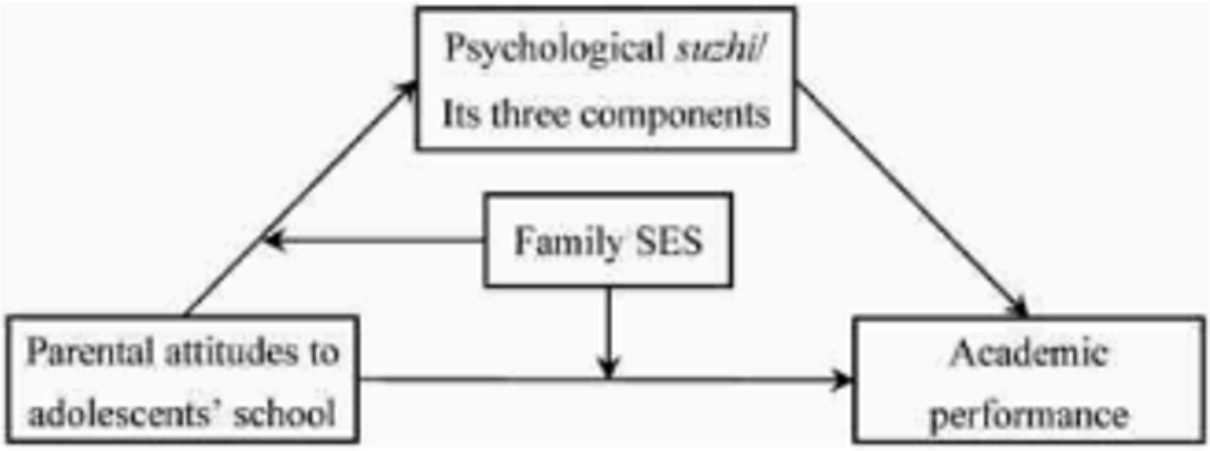


Figure 11

SES as Moderator Between Parental Math Beliefs and Math Achievement

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Tables.docx