LUMAT
International Journal on Math, Science and Technology Education

Research article

Parental involvement and children's mathematical outcomes: How values and communication relate to achievement and attitudes

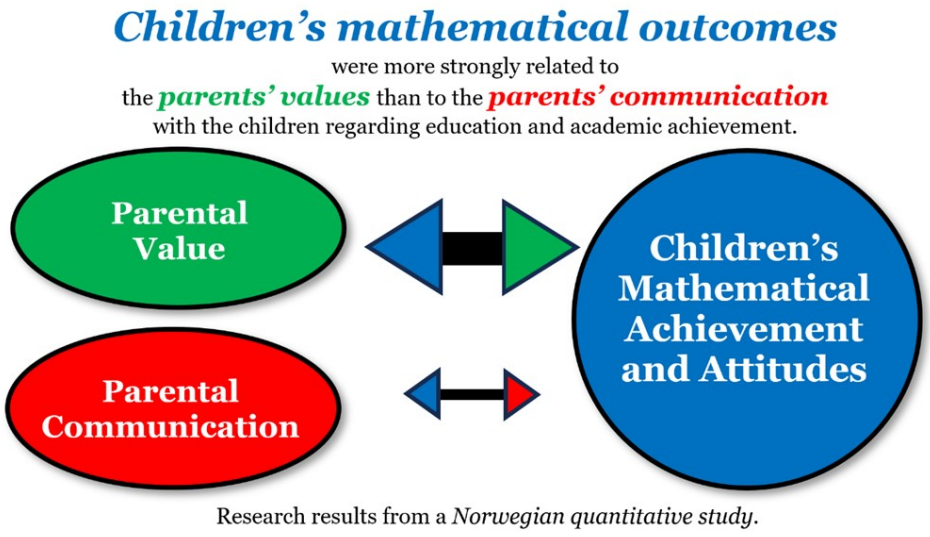
Arve Fiskerstrand[1,2], Markku S. Hannula[2] and Arne Kåre Topphol[1]

[1] Volda University College, Norway
[2] University of Helsinki, Finland

Abstract: Parental involvement is considered essential for children's educational outcomes. Previous research has connected parental involvement to children's mathematical achievement. However, it remains unclear how parental values and communication regarding education and academic achievement relate to children's mathematical achievement and attitudes. The current study aims to fill this gap by building on an earlier project with quantitative data conducted twice, consisting of mathematical tests for children and surveys for children, parents, and teachers. Based on exploratory factor analyses and a theoretically constructed model, we conducted confirmatory factor analyses to establish a structural equation model. The results showed that children's mathematical achievement and attitudes correlated with the parent's educational values. In addition, the analyses revealed that the children's mathematical outcomes were more strongly related to the parents' values than to the parents' communication with the children. Limitations of the study and implications for the importance of parents' values and communication were discussed.

Keywords: parents, parent involvement, mathematics education, elementary education, values

Correspondence: arve.fiskerstrand@hivolda.no



LUMAT Vol 12 No 3 (2024), 6. https://doi.org/10.31129/LUMAT.12.3.2146
Received 31 January 2024 / Accepted 23 May 2024 / Published 12 June 2024
Published by the University of Helsinki, Finland and LUMA Centre Finland.

1 Introduction

Parental involvement has been confirmed to be essential for children's educational (Boonk et al., 2018; Jeynes, 2022) and mathematical (Daucourt et al., 2021) outcomes and development. Parental involvement in mathematics ranges from homework help and learning activities at home to attending parent-teacher conferences and events at school. It may include parental goals, affections, beliefs, and values regarding the children's education, achievement, and learning of mathematics that parents possess, influence, and communicate with their children (Fiskerstrand, 2022). A prominent and recurring research result is that parents' expectations for children's academic achievement correlate highly with children's academic achievement, regardless of grade level and ethnicity (Kim, 2022; Wilder, 2014). Eccles et al. (1983) termed the parents as expectancy and value socialisers and proclaimed a direct relationship between parents as socialisers and the children's achievement attitudes. Overall, parents are recognised as an important influencing factor for children's mathematical outcomes. Parental involvement is about how they act and react towards their children and the more subtle influence through their attitudes, thoughts, and feelings towards school, education, learning, and mathematics.

Bishop et al. (2003) referred to values as the hidden persuaders in education and cultures, and Seah (2008) proclaimed the importance of valuing values in mathematics education. Moreover, Fuligni (1997) suggested that future studies should add parents to the equation and study parental values related to student's mathematical achievement and attitudes. This emphasis on parental values, combined with the documented importance of parental expectations for children's mathematical outcomes (Kim, 2022; Wilder, 2014), makes the Expectancy-Value Theory (Wigfield, 1994) a promising approach for studying parental involvement and relates to children's learning outcomes. This theory proclaims that when a person meets a specific task or a subject, the combination of *expectations* of success and a set of *values* will influence their *action* or *behaviour*. Further, Eccles et al. (1983) implemented a socialisation model to the theory, including parents' communication of values and expectations towards their children. Building on the research on values in mathematics education and elements of the Expectancy-Value Theory, this study focuses on the parents' values as an essential and adjacent variable to the parents' expectations. This article will examine how the parents' values and communication about them relate to the children's mathematical outcomes, which is important to know both for teachers and parents (Bishop et al., 2003; Fuligni, 1997; Seah, 2008). Specifically, we will explore the relative importance for the parent's having high *values* for their children's education and academic achievement and the subsequent *communication* regarding these values with their children. Is it sufficient that the parents encourage their children to study diligently, even if they themselves don't really value formal education? Finally, we will fill the gap in current research on parental values by analysing how parental values and communication relate with the children's achievement and attitude outcomes in mathematics. Is it primarily the parents' communication with

the children or their underlying values that are related to the children's mathematical achievement and attitudes?

Research on parental values has often emphasised how parents' values are transferred to their children by modeling. Gniewosz and Noack (2012) labelled the modeling effects of values from parents to children as the transmission of academic values. Other researchers have referred to the similar impacts by calling parents role models (Dotterer et al., 2009; Eccles et al., 1982), social agents (Chouinard et al., 2007; Wigfield et al., 2015), or academic socialisers (Bæck, 2017; Sonnenschein & Dowling, 2019). Eccles et al. (1983) found that the parent's diverse beliefs in the importance of mathematics correlated with the children's values related to mathematics, and this correlation was mediated by how the children viewed the parents' aspirations for them. One of the mechanisms by which the modeling of the parents' values to the children can be operationalised is through communication between the parents and the children. Several studies have emphasised the importance of quality and quantity in parents' communication with their children. An et al. (2019) discussed the effect of family communication on children's mathematics and science achievement and how different categories of communication were implemented and had a positive effect. Further, increased communication is associated with higher numeracy scores (Mahuro & Hungi, 2016), better mathematics grades, and positive affection for mathematics (Howard et al., 2019).

Turning to research on the children's achievement and mathematical outcomes which the parents' values and communication are aimed at in this study, reviews and meta-analyses (Boonk et al., 2018; Hill & Tyson, 2009; Jeynes, 2007; Sujarwo & Herwin, 2023; Wilder, 2014) demonstrate connections between parental involvement and children's academic achievement. In a literature review on parental involvement and mathematic outcomes, Fiskerstrand (2022) identified several studies that connected children's motivations for mathematics with parents' values. Some reviewed studies on children's achievement motivation and engagement in mathematics demonstrated correlations with parental factors, such as their values towards mathematics (Mansour & Martin, 2009; Martin et al., 2015). Moreover, Hong et al. (2010) showed a significant positive relationship between parents' mathematics value and students' academic achievement in high school. However, the research suggested that these relations were reciprocal rather than unidirectional, and similar results were obtained regarding parents' involvement and background (Schreiber, 2002). The reciprocal relation between parental factors and children's outcomes implied thus that the relations embraced were more complex than simply parental values transmitted to their children, as there also seemed to be an element of parents adapting their expectations to the actual academic success of their child. This reciprocity of relations calls for caution in what we may claim to find in our study related to values. Aiken Jr (1970) pointed out a similar reciprocal relation between achievement in mathematics and attitudes towards mathematics. Mata et al. (2012) proclaimed that being successful in mathematics, by grades and achievement, was essential for children's attitudes towards mathematics. On the other hand, Else-Quest et al. (2013) reported that attitudes were a strong predictor of mathematics achievement across gender and ethnicity.

However, in a meta-analysis (Ma & Kishor, 1997), it was pointed out that the relationship between mathematical attitudes and mathematical achievement was affected by various variables. For example, they found that the relationship strengthened from elementary grades (1 to 4) to upper elementary grades (5 and 6). Relating the parents to the attitude-achievement relationship in line with the focus of this study, Soni and Kumari (2017) showed that parents' anxiety and following attitudes towards mathematics acted as precursors to children's anxiety and attitudes and further to the children's achievement in mathematics. In addition, Mata et al. (2012) highlighted the social support of peers as highly significant in understanding these attitudes.

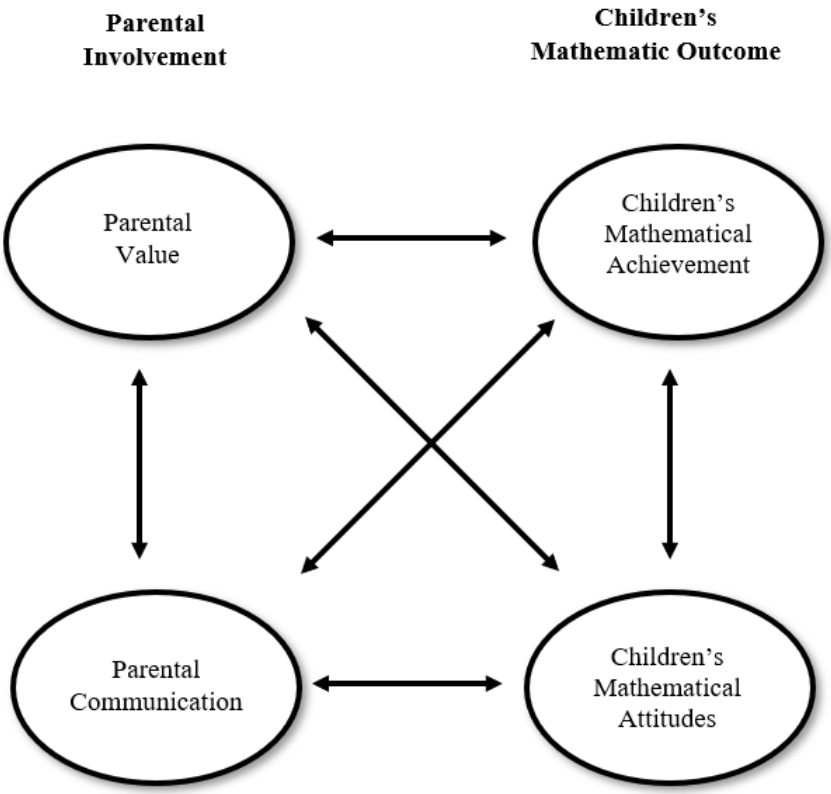
In the present study, we generated data from a Norwegian project as research about mathematics and parental involvement in a Norwegian context is limited. Bæck (2019b) has pointed out a contradiction between ideals and realities in Norwegian education policy and practice. The parents are considered important for the children's education, but the focus on home-school partnership (Epstein, 1987, 2019; Henderson & Mapp, 2002; Sheldon et al., 2010) through curricula and policy regulations (Bæck, 2019a; Kunnskapsdepartementet, 2007, 2020) may limit the parents' understanding of many aspects of parental involvement. In this respect, it is relevant to inquire about the relevance of parents' values and the communication of these values to their children. Bishop (2008) proclaimed that the teachers' underlying values in their mathematics teaching affect children's diverse outcomes in mathematics. Later, Bishop (2016) encouraged new research to increase the awareness of value also for parents. We consider the parents' values as a key factor in the parents' various involvements and the children's mathematical outcomes. The specific research questions we seek answers to in the current study are:

1. To what extent do parents value and communicate about children's education and academic achievement, and how do parents' values and communication correlate?
2. How are parents' values and communication about education and academic achievement connected with children's mathematical achievement and attitudes?

1.1 Theoretical model

In this study, we addressed parents' *values* and subsequent *communication* regarding the children's education and academic achievement and how these related to children's mathematical *achievement* and *attitudes*. We developed the theoretical model in Figure 1 as a working tool and hypothesis for the study to answer the research questions.

Figure 1. Theoretical Model of Parental Involvement and Mathematic Outcome



Note. Figure 1 presents a model for the relationships between parental involvement of values and communication and the children's mathematical outcomes regarding achievement and attitudes.

The variables were obtained from a literature review (Fiskerstrand, 2022) exploring indicators and research gaps related to parental involvement and children's mathematical outcomes. The term *value* has several meanings within various fields (Hitlin & Piliavin, 2004) and can generally be understood as the importance or worth of something or someone. We defined values as "moral beliefs to which people appeal for the ultimate rationales of action" (Spates, 1983, p. 28), and parental *communication* in this study was related to parental values as an action response (Hoover-Dempsey & Jones, 1997). Regarding the children's outcomes (Jeynes, 2022), Algarabel and Dasi (2001) defined *mathematical achievement* as a person's competence in a knowledge domain. Regarding the *mathematical attitudes*, we compiled the mathematical outcomes of affection and behaviour as two of three components in a tripartite attitude framework (Di Martino & Zan, 2010; Hannula, 2012; Hart, 1989). In the present study, the attitudes consisted of l*iking mathematics*, classified as an emotion, as part of affection as a collective term of beliefs, motivations, and emotions (Hannula, 2012), and *engagement in mathematics* defined as an action involvement of interest (Martin et al., 2015), as part of behavioural outcomes (Fiskerstrand, 2022).

We suggest the Expectancy-Value Theory (Eccles et al., 1983; Wigfield, 1994) as an applicable reference point for the model for two reasons. The theory is relevant as it contextualises values to expectations, which for decades has been proven to be the most

influential parental involvement indicator (Wilder, 2014) regarding children's educational outcomes. Secondly, the theory relates values to outcomes in line with the model for this study. In addition, the theory was established in the literature and used in research concerning parental involvement (Eccles et al., 1982; Frome & Eccles, 1998; Wigfield et al., 2015) with socialiser and modeling perspectives (Fiskerstrand, 2022), as well as related to mathematics (Froiland & Davison, 2016).

2 Methodology

This study has a quantitative design as we seek answers through extensive data from the Norwegian SPEED project (Haug, 2017), named The Function of Special Education. The SPEED project aimed to investigate how special education was integrated into ordinary education. Relevant variables, the data volume, and the methodological design of single measurement surveys with two data collections made the data from the SPEED project suitable for our correlational study with aims and research questions related to children's mathematical outcomes and parental involvement. To justify the original SPEED project and to clarify this study's independent research contribution, we provide in Table 1 an overview and distinction of the contributions from the SPEED project and this study. In addition, Table 1 gives an initial picture of the data collection and analysis of the SPEED project and this study to guide the reader through the methodology section. The following sections will emphasise the methodological considerations, selections, procedures, and analyses relevant to the current research.

Table 1. Data Collection and Analysis

	The SPEED project	**This Study**
Data collection	Project approval and implementation Ethical considerations and approvals Processing of samples and participants Construction of measuring instruments Collection and structuring of data	Selection of sample and participants Selection of materials
Data analyses	Validation of sample and participants Reliability analyses of measuring instruments	Validation of selections Exploratory factor and reliability analyses Screening and optimisation of data Confirmatory factor analyses Structural equation modeling

Note. Table 1 shows the distribution, content and progression of data collection and analyses in the SPEED project and this study.

Abbreviation: SPEED=The Function of Special Education.

2.1 Participants and sample

Children aged 10 to 15 participated in the SPEED project, as did their teachers and parents, representing various social and ethnic backgrounds. The participant children were from 29 primary and secondary schools of diverse sizes in urban and rural areas of two medium-sized municipalities in Norway. All children in grades 5, 6, 8, and 9, as well as their parents and teachers, were invited to respond to surveys in spring 2013 (S1) and again in spring 2014 (S2). The children participated in mathematical tests as well. Both the parents and the teachers answered the surveys individually for each of the children. The SPEED project included 3380 children with their teachers and parents. The data collections (S1; S2) achieved an acceptable representation of children (80 per cent; 78 per cent), teachers (75 per cent; 68 per cent), and parents (47 per cent; 38 per cent). Table 2 presents the responses for each measuring instrument used in this study and how many were received in total and on each data collection (S1 and S2).

Table 2. Numbers of Respondents

	Total	**S1**	**S2**
Children's Mathematics test	2786	2544	2254
Children's Survey	2769	2646	2574
Teacher's Survey	2595	2485	2308
Parent's Survey	1938	1572	1296

Note. Table 2 presents the number of participants who responded to the children's mathematics test and the surveys for children, teachers, and parents.

Abbreviation: S1=Data collection spring 2013, S2=Data collection spring 2014.

As we compiled data from the various measurement sources, we benefited from the strength that each child's data was linked to data from their parents and teacher and between the data sets. In addition, the repetitive and longitudinal nature of the data opened several different checkpoints for validity and reliability. Based on the requirement in our analysis for complete data, the parent group (S1: N=1572; S2: N=1296) constituted this study's data size.

2.2 Surveys and tests

Topphol et al. (2017) and Opsvik and Skorpen (2017) reviewed the original project's materials and methodological considerations. The surveys and tests used in the original SPEED project were digital. They followed Norwegian research standards with informed consent from participants and approval from the national ethics committee (Topphol et al., 2017) and the anonymised data were later published for open access (Haug, 2018). The

questions in the surveys for the children, parents, and teachers were argued for theoretically as being inspired and established from literature and previously tested national and international measuring instruments (Gresham & Elliott, 1990; Harter, 2012; Nordahl, 2000). The surveys covered a wide range of areas, such as child-teacher-parent relationships and cooperation, teaching and learning environment at school and home, and questions related to the children's well-being, social competence, academic achievement, and attitudes. The variable constructions of the various question groups had satisfactory reliability, with a Cronbach's Alpha ranging from .67 to .87 (Topphol et al., 2017). For the current study, we selected questions related to the variables in the model in Figure 1 to answer our research questions. The Appendix details the selected questions from the surveys used in this study with an English translation of the original Norwegian survey questions.

In the mathematics tests from the SPEED project, all the children completed 40 tasks. The oldest children, aged 13–15, received 12 additional tasks due to the age-adjusted extended curriculum. The test was paper-based, with digitising through optical scanning. The instrument design was multiple-choice tasks with distractors and "do not know" alternatives. The children were tested in mathematical topics such as arithmetic, fractions, decimal numbers, statistics, and geometry. The tasks had various issues and contexts from daily life through word and non-word problems. Opsvik and Skorpen (2017) discussed discriminations, workload, degree of difficulty, inner consistency, and construction of the tests. They concluded that psychometric data was acceptable, with Cronbach's Alpha ranging from .89 to .92 for the various grade levels. Topphol (2018) described how the children's mathematical scores were generated to a percentage level, and the test's diversity of mathematical topics facilitates arguments for acceptable content validity of the children's mathematical achievement. The results were also similar to national statistics (Topphol, 2018), strengthening the construct validity. For the analyses of the current study, we normalised the mathematics test results by *z*-score per grade to eliminate the effect of age to be able to use the children's overall mathematics test results from all grade levels together. In summary, the reliability of the surveys and the mathematics tests was documented, and we considered the data obtained valid for use in this study.

2.3 Variable selections and validation

The selected parental involvement questions in the parent survey provided the rationale to carry out an exploratory factor analysis (EFA) to find latent underlying factors in the first data set (S1) and potentially confirm the model in Figure 1. Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) test results of .757 and $p<.001$ significance on Bartlett's test of sphericity strengthened the rationale of suitable data for factor analysis. The EFA confirmed high commonalities [.666; .816] for the first dataset (S1), and a separate factor extraction by principal component analysis (PCA) included an Oblimin rotation with Kaiser Normalisation as presented by the Structure Matrix in Table 3.

Table 3. Factor Analysis of Parental Involvement Indicators (S1; *N*=1572)

Parental Involvement Indicators	**Factor Loadings**
Parental Values (Ω=.674)	
Value of Achievement	.883
Value of Education	.869
Parental Communication (Ω=.630)	
Communication on Achievement	.861
Communication on Education	.805

Notes. Table 3 presents factor loadings for the parental involvement indicators of values and communication. Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalisation. Factor loadings >.4.

Abbreviation: Ω=McDonald's Omega.

The four parent involvement indicators selected for this study had satisfying factor loadings [.805; .883] documenting correlations to underlying factors, in addition to significant group reliability of McDonald's Omega at .674 and .630, respectively, for parental *values* and *communication*.

Turning to the children's mathematical outcome, the *achievement* variables originated from the summary score of the children's mathematics test. Together with the teacher's evaluation of the children's achievement level, the measure of the achievement had an acceptable convergent validity. The *attitude* variables were based on the children's survey answers about whether they *like mathematics* and their responses to *mathematical engagement*. Communalities for the achievement variables [.762; .790] and the attitude variables [.512; .678] were documented at a high level in the first dataset (S1) and confirmed with the KMO test and Bartlett's test of sphericity results, with .782 and $p<.001$ significance, respectively. A structure matrix of the EFA at the first dataset (S1) presented in Table 4 documents two composed latent factors of achievement and attitude from emotions and engagement with a high factor loading above .7 and reliability of McDonald's Omega at .877 and .774 for the children's *achievement* and *attitude*, respectively.

Table 4. Factor Analysis of Mathematical Outcome Indicators (S1; *N*=1572)

Mathematic Outcome Indicators	**Factor Loadings**
Children's Achievement (Ω=.877)	
Children's Mathematic Test Achievement	.885
Teacher Mathematic Achievement Evaluation	.871
Children's Attitude (Ω=.774)	
Children's Mathematic Reported Emotion	.809
Children's Mathematic Reported Engagement	.737

Notes. Table 4 presents factor loadings for the mathematical achievement and attitude outcome indicators. Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalisation. Factor loadings >.4.

Abbreviation: Ω=McDonald's Omega.

In summary, the EFA's and reliability analyses on the first data set (S1) validated the model and statistically demonstrated the potential for the compilation of variables. The analytical work on the first data set 8S1) thus laid the basis for confirmatory factor analyses (CFA) on the second dataset (S2) with the aim of establishing a structural equation model (SEM).

2.4 Data screening and optimisation

Further analyses required complete data, and for that reason, we conducted a missing value analysis with regression estimates to preserve all proportions and dimensions of the second dataset (S2) in further analysis. We omitted cases with completely missing responses. Additional screening for missing patterns by Little's MCAR test (Little, 1988) gave a significance of $p<.001$ for completely missing randomness. A *t*-test demonstrated pairwise missing randomness. Finally, imputations by expectation maximisation (EM) were executed within a 5 per cent level (Graham et al., 2003; Hair et al., 2018; Tabachnick & Fidell, 2014) of missing data values. We did this to avoid biases in the data due to the degree of completion and to achieve the best possible overall representation of the parents.

Further, we reviewed the psychometric data of the variables of the second dataset (S2), as presented in Table 5, to assess the normality of distribution and suitability for further analyses. With a potential and actual value range equal [1, 4] for all the parental involvement variables, the data showed values averaging at M = 3.82 and SD = .39, documenting a preponderance of parents responding highly positively to how they *value* and *communicate* with their children regarding academic achievement and education. Having skewness and kurtosis on the edge of acceptable to a normal distribution (Byrne, 2011; Hair et al., 2018) methodically entails caution and prudence but also reflects the parents' majority of positive responses.

Table 5. Psychometric Data Properties of Study Variables (S2; *N*=1296)

Variables	*M*	*SD*	Skewness	Kurtosis
Parent Involvement Variables				
Value of Achievement	3.83	.385	-1.957	2.486
Value of Education	3.91	.294	-2.879	6.718
Communication of Achievement	3.80	.453	-2.563	8.272
Communication of Education	3.75	.447	-1.376	.516
Children's Mathematic Outcome Variables				
Mathematic Test Achievement	69.21	17.114	-.787	.461
Mathematic Reported Achievement	4.28	1.161	-.468	-.339
Mathematic Emotion	3.58	1.086	-.657	-.042
Mathematic Engagement	4.24	.770	-1.213	2.409

Note. Table 5 provides an overview of the mean, standard deviation, skewness, and kurtosis for the study's variables for parental involvement and mathematical outcome.

Abbreviations: *M*=mean, *SD*=standard deviation.

The Mathematic Test Achievement original mean values increased (S1: 60.26; S2: 69.21), and the standard deviation remained stable (S1: 17.555; S2: 17.114) in the data from the first year (S1) to the second year (S2). A paired sample *t*-test with corrected standard deviation (*SD*) of the difference calculated the increase as Cohen's *d*=.516. This result is slightly above *d*=.4, which Hattie (2012) suggested as one year of educational growth or learning. Thus, we proclaimed the increase of mean values as reliable results for a test-retest with similar tasks and assumed that this, together with stable standard deviation, was an acceptable measurement accuracy.

3 Results

3.1 Composition of models

To determine the factor structure extracted from the EFA at the first dataset (S1), we executed two confirmatory factor analyses (CFA) at the second dataset (S2) as a precursor to the structural equation model (SEM). First, we continued the original parent involvement variables of *values* and *communication* from the EFA and the theoretical model in Figure 1 in the CFA at the second data set and constituted a preliminary parent involvement model. Secondly, we included the children's mathematical achievement and attitude variables in constructing a mathematical outcome model. A double set of model fit values of absolute (SRMR and AGFI), comparative (TLI and NFI) and non-centrally parameter (CFI and RMSEA) fit indices are presented in Table 6 to add the probability of

acceptance of the models, as well as validating them for further integration in a SEM.

Table 6. Model Fit Indices for CFA Constructed Models

CFA model *Acceptable model fit* *Good model fit*	**χ^2 (df)**	**SRMR** *<.080*	**AGFI** *>.900* *>.950*	**TLI** *>.900* *>.950*	**NFI** *>.900* *>.950*	**CFI** *>.900* *>.950*	**RMSEA** *<.080* *<.050*
Parent Involvement Model	11.442 (2)	.019	.978	.976	.990	.992	.060
Mathematic Outcome Model	8.734 (1)	.013	.967	.968	.994	.995	.077

Note. Table 6 provides an overview of the result values from six model fit indices related to the constructed models for parental involvement and mathematical outcome.

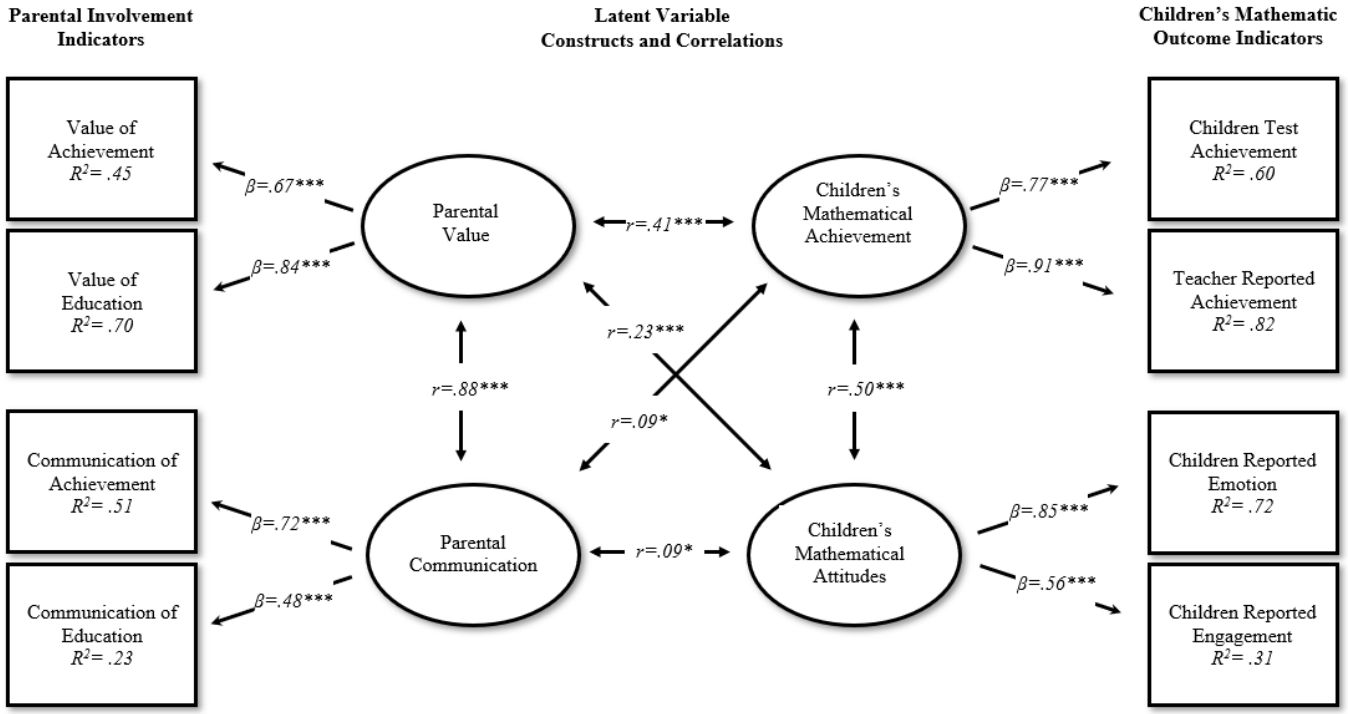
Abbreviations: χ^2=Chi Square, df=degree of freedom, SRMR=Standardised Root Mean Square Residual, AGFI=Adjusted Goodness of Fit Index, TLI=Tucker-Lewis Index, NFI=Normed Fit Index, CFI=Comparative Fit Index, RMSEA=Root Mean Square Error of Approximation.

The level of acceptable and good standards for model fit indices is disputed in the literature (Bentler, 1990; Kline, 2023; West et al., 2012), and the selection of indices and implied limits for acceptable and good model fit for this study primarily follows the indications of Hu and Bentler (1999). The model fit indices stated in Table 6 documented good model fit for both models and for several of the indices, the values were significantly within limits.

3.2 Structural equation modeling

The two models were further implemented as elements in constructing a final structural equation model, as presented in Figure 2. Observed and latent variables from the parental involvement model and the mathematical outcome model follow the model in Figure 1 and the statistical underlying calculations for the models.

Figure 2. Structural Equation Model for Parental Involvement and Mathematical Outcome



Notes. Figure 2 is the final structural equation model showing values for squared multiple correlations, standardised regression weights, and correlations between observed and latent variables. The latent variables are parental values and communication and children's mathematical achievement and attitudes, reflecting the model in Figure 1.

Abbreviations: R^2 = squared multiple correlations, β = standardised regression weights, r = correlation weight.

Significance values: ***=.000; **=<.01; *=<.05, Model fit indices: χ2(df)=9,824(8), SRMR=.011, AGFI=.992, TLI=.998, NFI=.996, CFI=.999, RMSEA=.013.

Model modifications: The addition of error residuals for all observed variables and six theoretical or statistical model fit suggested significant correlation paths.

The model fit indices prescribed in the structure model's table note were excellent. They documented a well-constructed model for analysis, confirming the initial model fit indices for the parent involvement and mathematical outcome model from Table 6. The squared multiple correlation coefficients (R^2) average (.54) was acceptable and documented sufficient covariation between observed and latent variables. Finally, all the standardised regression coefficients (β) and the correlation coefficients (r) had a high degree of significance. Together, they provided a foundation for suggesting results and discussing the stated values.

3.3 Key findings

The research questions for the study were (1) To what extent do parents value and communicate about children's education and academic achievement, and how do parents' values and communication correlate? (2) How are parents' values and communication about education and academic achievement connected with children's mathematical achievement and attitudes?

Regarding the first research question concerning the extent of parent's values and communication about children's education and academic achievement, we obtained answers from the psychometric data in Table 5. With a value range of [1,4], the average *M* was from 3.75 to 3.91, and *SD* was from .294 to .453, which indicated that parents largely reported positive values and communications related to education and academic achievement. Furthermore, SEM analysis concluded with a significant correlation coefficient (r = .88***) between the two latent variables for *values* and *communication*, so the connection was assumed to be highly present.

For the second research question, the SEM analysis indicated significant correlation coefficients for all four connections between the two parent latent factors – values and communication – and the two children latent factors – mathematical achievement and mathematical attitude. However, primarily, the connection between the parents' values and the children's mathematical achievement showed a marked correlation (r = .41***). In addition, the parents' values correlated with the children's attitudes toward mathematics (r = .23***). Despite the high correlation between the parents' values and communication (r = .88***), the model revealed a markedly lower correlation between the parents' communication and the children's outcome in terms of both achievement (r = .09*) and attitudes (r = .09*).

4 Discussion

The current study reveals two main findings that answer the study's research questions, extend previous research, and provide the content and structure of further discussion. First, we will emphasise the levels of and connections between parental values and communication regarding children's education and academic achievement reported in a Norwegian context. Second, we will highlight that children's mathematical outcomes seem more strongly related to the parents' values than to the parents' communication regarding education and academic achievement.

4.1 High parental values

To a large extent, the Norwegian parents in this study place high value on their children's academic achievement and education, and this result extends international trends (Fuligni, 1997). How the parental role in Norway unfolds regarding values and

communication in this study can thus add knowledge in a Norwegian context where law and policy documents (Bæck, 2019a; Kunnskapsdepartementet, 2007, 2020) focus on the home–school partnership and the school's responsibility as a professional part in the formal school-initiated collaborations. While the parents' responsibilities for involvement through cooperation are implicit, we argue that the Norwegian and international emphasis for school-home partnership (Epstein, 2019; Nordahl, 2007) may benefit from a broader understanding of various aspects of parental involvement which largely has the home as an arena (Fiskerstrand, 2022). Specifically, parents, educators, and researchers could benefit from a being aware of how the parents' position and involvement through values and communication impact children's learning (Hoover-Dempsey & Jones, 1997).

4.2 The values, achievement, and attitude triangle

We found a high correlation between Norwegian parents' values and the children's mathematical achievement and attitudes and between the children's mathematical achievement and attitudes. First, the findings indicate a relationship between the parents' values of education and academic achievement and their children's mathematical outcomes. While the parental values in earlier studies related to their view of and attitudes towards mathematics (Eccles et al., 1983; Martin et al., 2015), this study fills a gap by describing the parental values concerning education and academic achievement. Secondly, the strong correlation between mathematical achievement and attitude extends earlier research (Ma & Kishor, 1997; Schreiber, 2002) to a Norwegian context, reinforcing the impression that the relationship is universal and independent of cultural context (Fiskerstrand, 2022). Thirdly, the study indicates that the parents' values are somewhat weaker related to the children's mathematical attitudes than their mathematical achievement. Although the present study only demonstrates correlation, it is reasonable to suggest that it could potentially correspond to previous research on modeling (Dotterer et al., 2009; Eccles et al., 1993) or the socialising effect (Bæck, 2017; Sonnenschein & Dowling, 2019; Wigfield et al., 2015) of the parent's values. The children could be influenced to be motivated to achieve in accordance with their parents' values of achievement (Mansour & Martin, 2009; Martin et al., 2015) without this necessarily entailing that they like or want to be engaged in mathematics. Using terms from the Self-Determination Theory (Deci & Ryan, 2012) and relating to parents (Joussemet et al., 2008), we can interpret this as an introjected regulation of motivation where the children unconsciously adopt their parents' values as a motivation to achieve (Howard et al., 2021). If the children achieve due to external motivation to calibrate with the parents' values, motivation and subsequent attitudes can decrease when adolescents build greater autonomy and peers become a more critical reference group than parents. Finally, we see a specific connection between parents' achievement values and the children's mathematical achievement; this now leads us to discuss how the parents' achievement values are communicated.

4.3 The communication challenge

Hoover-Dempsey and Jones (1997) suggested that the critical issue for parental involvement appeared to be the parents' actions that followed their values rather than the nature of the specific values. With a majority of Norwegian parents having positive values regarding education and academic achievement, it is reasonable to assume that the parents express themselves positively about education and academic achievement towards their children. This connection is also demonstrated in the analyses and confirms previous research on the importance of parent-child communication (An et al., 2019; Fiskerstrand, 2022; Mahuro & Hungi, 2016) for children's mathematical achievement. However, we highlight a specific research contribution of this study, as in contrast to the parental values, parental communication regarding education and academic achievement has a far lower correlation with the children's mathematical achievement and attitudes. Why do the children's mathematical achievement and attitudes correlate highly with the parents' values but less with the parents' communication regarding education and academic achievement? Is this a consequence of parents talking more about school and education when the children achieve below expectations? While further research is needed to conclude this question, we assume as a hypothesis that the type, volume, content, and quality of the communication can have an impact, as well as the situation-specific surroundings and which of the parents are communicating (Howard et al., 2019; McNeal Jr, 2014). For example, An et al. (2019) demonstrated that communication consisting of help and guidance correlated with high achievement for some families. A parent who actively expresses a desire to help, in a sense, indicates positive values both to education and to achieving.

Finally, we will highlight the potential theoretical relevance of this study of parental values to the international research on parental expectations, documented as the outstanding, influential parental involvement indicator (Boonk et al., 2018; Fiskerstrand, 2022; Jeynes, 2022; Wilder, 2014). The expectation-value theory (Eccles et al., 1983; Wigfield, 1994) highlights the link between values and expectations as a basis for action, and the present study expands the understanding of and the position of parents' values for children's mathematical achievement in particular. The parental achievement values follow the parental achievement expectations as a significant factor for children's mathematical outcomes of achievement and attitudes. Other studies have highlighted links to communication through encouragement and learning support (Boonk et al., 2018), so it is reasonable to assume that the children would profit from parents' values being expressed communicatively through positive expectations to get positive mathematical outcomes for the children.

4.4 Conclusion

The present study has shown that Norwegian parents highly value and communicate positively about education and academic achievement. It also highlights correlational differences between these parental values and communication and the children's mathematical achievement and attitude outcomes. Firstly, the parents' values for education and academic achievement correlate significantly to the children's achievement and attitudes in mathematics, even if the research design doesn't allow drawing conclusions about a causal relationship. For example, we can assume that the parents' values can impact the children's mathematical outcomes. Still, the children's achievement level can also affect how the parents value education and academic achievement. Secondly, despite the apparent correlation between parental values and communication about education and academic achievement, we found a significantly lower correlation between parental communication and the children's mathematical outcomes. Thus, we argue that aspects of the parent's communication with the children, or aspects of the children's mathematical achievement and attitudes, can cause a weaker connection between the parents' communication than their values towards the children's mathematical outcomes. New studies are required to find the causal relationships if, for example, children with a low achievement level or a bad attitude towards mathematics may entail more communication from parents who value education and academic achievement highly. Alternatively, there can be qualitative aspects of parents' communication that explain the low correlation with the children's mathematical achievement and attitudes. Previous studies have emphasised the importance of positive parental expectations regarding educational achievement (Boonk et al., 2018; Jeynes, 2022) as well as mathematical outcomes (Fiskerstrand, 2022). This study demonstrates that parents' values, in the same way and seen in context with parents' expectations (Wilder, 2014), may be an essential factor to consider when children's mathematical achievement and attitudes are being investigated. Combined with the present study's documentation of correlational differences between parents' values and communication, it is reasonable to assume that the children's mathematical achievement and attitudes could benefit from parents' communication, bridging positive expectations.

4.5 Limitations

This study has certain limitations. Firstly, the SPEED project's initial sample selection of the two municipalities does not meet the requirement for statistical randomness. However, we argue for a cautious assessment of generalising the results of this study. This is due to the cultural and geographical heterogeneity of the municipalities and schools, the diversity of socio-economic status among the respondents (Haug, 2017), the high percentage of participation in the data collection, the confirmation of psychometric data similarities to national statistics (Topphol, 2018), and the size and strength of the data. Secondly, research related to parents and children is strengthened when socio-economic

status is considered, and the original data included information about the parents' ethnicity and level of education. However, initial analyses confirmed marginal correlations and a lack of significance for socio-economic status variables. Without any significant moderating or mediating effect, they were excluded from further analyses. Finally, the choice of terms and theoretical connections contributes to a justification of the study's affiliation and position in the research field. Equally, it can constitute a lack of awareness of other perspectives, and other theoretical and analytical angles could open up for different interpretations.

4.6 Implications

The degree and quality of parents' involvement are related to children's educational opportunities, and this study may inspire to have this emphasised in school and educational practice, politics, and research. This study defines the space between ideals and realities regarding the parents' involvement. It suggests a direction for attention to improve the environment for children's mathematical outcomes, emphasising the parent's involvement through their values and communication and how these relate to the children's mathematical achievement and attitudes. The study shows that the parents' values of children's education and academic achievement are related to the children's mathematical outcome to a greater extent than how they preach about it. From the results of this research on the parents' values and communication, we will suggest relevance for how school owners, school leaders, and teachers collaborate with the parents and impart knowledge about the importance of parental values and how they communicate with the children regarding education and achievement. For the good of children's education and mathematical outcome, we encourage school leaders and teachers to acknowledge the parents as a resource regarding the children's education, both in terms of collaboration and for their position as parents.

Research ethics

Author contributions

Arve Fiskerstrand was responsible for establishing the study's ideas and research questions, carrying out methodology, analyses, and text productions, in addition to coordinating co-writing, revision work, and the publication process.

Markku S. Hannula assisted with the methodological work and analyses and reviewed all parts of the article.

Arne Kåre Topphol contributed to the methodological work in the current study and reviewed all parts of the article. He participated as a researcher in the original SPEED project.

Funding

The Research Council of Norway supported the original SPEED project under Grant number 218326. This study has not received any form of funding.

Informed consent statement

Informed consent was obtained from all research participants.

Acknowledgements

The study is based on data from the SPEED project, led by Peder Haug from Volda University College and Thomas Nordahl from Hedmark University College.

Conflicts of Interest

The authors declare no potential conflict of interest.

Appendix

The following questions and answer options constituted the survey variables used in the study. An English *translation* is done in the best possible way regarding linguistic differences in terms.

Parent survey questions

- Jeg/vi er opptatt av[1] at vårt barn skal gjøre det skolefaglig sett bra på skolen.
  I/we value our child doing well academically at school.
- Jeg/vi snakker ofte med barnet om hvordan han/hun har det og trives på skolen.
  I/we often communicate with the child about well-being at school.
- Jeg/vi er opptatt av[1] at vårt barn skal forstå at skolegang og utdanning er viktig.
  I/we value our child understanding the importance of school and education.
- Jeg/vi oppmuntrer ofte barnet til å gjøre det bra på skolen.
  I/we often encourage the child to do well at school.

Parent survey answer options

- Stemmer meget godt*Is very correct*
- Stemmer ganske godt*Is fairly correct*

[1] "Opptatt av" lacks a one-to-one translation but is interpreted to describe a value that the parents possess. In other contexts, the term can be translated to passionate about, keen to, preoccupied with, fascinated by, interested in, caring about, and concerned with.

- Stemmer ganske dårlig *Is fairly wrong*
- Stemmer svært dårlig *Is very wrong*

Teacher survey questions

Gi en vurdering av elevenes skolefaglige prestasjoner i matematikk.

Give an assessment of the children's achievements in mathematics.

Teacher survey answer options

1 svært lav kompetanse *very low competence*

2 lav kompetanse *low competence*

3under middels kompetanse *below average competence*

4over middels kompetanse *above average competence*

5høy kompetanse *high competence*

6 svært høy kompetanse *very high competence*

Children survey questions

Jeg liker faget matematikk.

I like the subject of mathematics.

Jeg følger godt med når læreren forklarer noe i matematikktimene.

I pay close attention when the teacher explains something in math lessons.

Children survey answer options

- Ja, alltid *Yes, always*
- Ofte *Often*
- Av og til *Sometimes*
- Sjelden *Rarely*
- Nei, aldri *No, never*

References

Aiken Jr, L. R. (1970). Attitudes toward mathematics. *Review of Educational Research, 40*(4), 551–596. https://doi.org/10.3102/00346543040004455

Algarabel, S., & Dasi, C. (2001). The definition of achievement and the construction of tests for its measurement: A review of the main trends. *Psicologica, 22*(1), 43–66.

An, G. Q., Wang, J. Y., & Yang, Y. (2019). Chinese parents effect on children's math and science achievements in schools with different SES. *Journal of Comparative Family Studies, 50*(2), 139–161. https://doi.org/10.3138/jcfs.50.2.003

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin, 107*(2), 238–246. https://doi.org/10.1037/0033-2909.107.2.238

Bishop, A., Seah, W. T., & Chin, C. (2003). Values in mathematics teaching - The hidden persuaders? In A. Bishop, K. Clements, C. Keitel, J. Kilpatrick, & F. Leong (Eds.*), International handbook of mathematics education* (2 ed., pp. 717–765). Kluwer.

Bishop, A. J. (2008). Mathematics teaching and values. Education - an intersection in need of research. In P. Clarkson & N. Presmeg (Eds.), *Critical issues in mathematics education: Major contributions of Alan Bishop* (pp. 239–253). Springer. https://doi.org/10.1163/9789087901509_013

Bishop, A. J. (2016). Can values awareness help teachers and parents transition preschool learners into mathematics learning? In *Mathematics education in the early years: Results from the POEM2 conference 2014* (pp. 43–56). Springer. https://doi.org/10.1007/978-3-319-23935-4

Boonk, L., Gijselaers, H. J., Ritzen, H., & Brand-Gruwel, S. (2018). A review of the relationship between parental involvement indicators and academic achievement. *Educational Research Review*, *24,* 10–30. https://doi.org/10.1016/j.edurev.2018.02.001

Byrne, B. M. (2011). *Structural equation modeling with Mplus: Basic concepts, applications, and programming* (1 ed.). Routledge. https://doi.org/10.4324/9780203807644

Bæck, U.-D. K. (2017). It is the air that we breathe. Academic socialization as a key component for understanding how parents influence children's schooling. *Nordic Journal of Studies in Educational Policy, 3*(2), 123–132. https://doi.org/10.1080/20020317.2017.1372008

Bæck, U. D. K. (2019a). *Hjem-skole-samarbeid* (1 ed.). Fagbokforlaget.

Bæck, U. D. K. (2019b). Parental involvement in Norway – ideals and realities. In A. Paseka & D. Byrne (Eds.), *Parental involvement across European education systems: Critical perspectives* (pp. 77–89). Routledge.

Chouinard, R., Karsenti, T., & Roy, N. (2007). Relations among competence beliefs, utility value, achievement goals, and effort in mathematics. *British Journal of Educational Psychology, 77*(3), 501–517. https://doi.org/10.1348/000709906X133589

Daucourt, M. C., Napoli, A. R., Quinn, J. M., Wood, S. G., & Hart, S. A. (2021). The home math environment and math achievement: A meta-analysis. *Psychological Bulletin, 147*(6), 565–596. https://doi.org/10.1037/bul0000330

Deci, E. L., & Ryan, R. M. (2012). Self-determination theory. In P. A. M. Van Lange, A. W. Kruglanski, & E. T. Higgins (Eds.), *Handbook of theories of social psychology* (Vol. 1, pp. 416–437). Sage.

Di Martino, P., & Zan, R. (2010). 'Me and maths': Towards a definition of attitude grounded on students' narratives. *Journal of Mathematics Teacher Education, 13*, 27–48. https://doi.org/10.1007/s10857-009-9134-z

Dotterer, A. M., McHale, S. M., & Crouter, A. C. (2009). The development and correlates of academic interests from childhood through adolescence. *Journal of Educational Psychology, 101*(2), 509–519. https://doi.org/10.1037/a0013987

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motives: Psychological and sociological approaches* (pp. 75–146). W. H. Freeman.

Eccles, J. S., Adler, T. F., & Kaczala, C. M. (1982). Socialization of achievement attitudes and beliefs: Parental influences. *Child development, 53*(2), 310–321. https://doi.org/10.2307/1128973

Eccles, J. S., Midgley, C., Wigfield, A., Buchanan, C. M., Reuman, D., Flanagan, C., & Mac Iver, D. (1993). Development during adolescence: The impact of stage-environment fit on young adolescents' experiences in schools and in families. *American Psychologist, 48*(2), 90–101. https://doi.org/10.1037/10254-034

Else-Quest, N. M., Mineo, C. C., & Higgins, A. (2013). Math and science attitudes and achievement at the intersection of gender and ethnicity. *Psychology of Women Quarterly, 37*(3), 293–309. https://doi.org/10.1177/0361684313480694

Epstein, J. L. (1987). Toward a theory of family-school connections: Teacher practices and parent involvement. In K. Hurrelmann, F.-X. Kaufmann, & F. Lösel (Eds.), *Social intervention: Potential and constraints* (pp. 121–136). Walter De Gruyter. https://doi.org/10.1515/9783110850963.121

Epstein, J. L. (2019). Theory to practice: School and family partnerships lead to school improvement and student success. In *School, family and community interaction* (pp. 39–52). Routledge.

Fiskerstrand, A. (2022). Literature review – Parent involvement and mathematic outcome. *Educational Research Review*, 37. https://doi.org/10.1016/j.edurev.2022.100458

Froiland, J. M., & Davison, M. L. (2016). The longitudinal influences of peers, parents, motivation, and mathematics course-taking on high school math achievement. *Learning and Individual Differences, 50*, 252–259. https://doi.org/10.1016/j.lindif.2016.07.012

Frome, P. M., & Eccles, J. S. (1998). Parents' influence on children's achievement-related perceptions. *Journal of Personality and Social Psychology, 74*(2), 435–452. https://doi.org/10.1037/0022-3514.74.2.435

Fuligni, A. J. (1997). The academic achievement of adolescents from immigrant families: The role of family background, attitudes, and behavior. *Child development, 68*(2), 351–363. https://doi.org/10.1111/j.1467-8624.1997.tb01944.x

Gniewosz, B., & Noack, P. (2012). The role of between-parent values agreement in parent-to-child transmission of academic values. *Journal of Adolescence, 35*(4), 809–821. https://doi.org/10.1016/j.adolescence.2011.11.007

Graham, J. W., Cumsille, P. E., & Elek-Fisk, E. (2003). Methods for handling missing data. In J. A. Schinka & W. F. Velicer (Eds.), *Research methods in psychology* (Vol. 2, pp. 87–114). https://doi.org/10.1002/0471264385.wei0204

Gresham, F. M., & Elliott, S. N. (1990). *Social skills rating system*. American Guidance Service.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2018). *Multivariate data analysis* (Vol. 8). Cengage Learning EMEA.

Hannula, M. S. (2012). Exploring new dimensions of mathematics-related affect: Embodied and social theories. *Research in Mathematics Education, 14*(2), 137–161. https://doi.org/10.1080/14794802.2012.694281

Hart, L. E. (1989). Describing the affective domain: Saying what we mean. In D. B. McLeod & V. M. Adams (Eds.), *Affect and mathematical problem solving* (pp. 37–45). Springer. https://doi.org/10.1007/978-1-4612-3614-6_3

Harter, S. (2012). *The construction of the self: Developmental and sociocultural foundations* (2 ed.). Guilford.

Hattie, J. (2012). *Visible learning for teachers: Maximizing impact on learning*. Routledge. https://doi.org/10.4324/9780203181522

Haug, P. (2017). *Spesialundervisning, innhald og funksjon* (Vol. 17). Samlaget.

Haug, P. (2018). *Funksjonen til spesialundervisninga, 2017 [Datasett]* NSD - Norsk senter for forskningsdata AS. https://doi.org/10.18712/NSD-NSD2496-V1

Henderson, A. T., & Mapp, K. L. (2002). *A new wave of evidence: The impact of school, family, and community connections on student achievement*. *Annual synthesis, 2002*.

Hill, N. E., & Tyson, D. F. (2009). Parental involvement in middle school: A meta-analytic assessment of the strategies that promote achievement. *Developmental Psychology, 45*(3), 740–763. https://doi.org/10.1037/a0015362

Hitlin, S., & Piliavin, J. A. (2004). Values: Reviving a dormant concept. *Annual review of psychology, 30,* 359–393. https://doi.org/10.1146/annurev.soc.30.012703.110640

Hong, S., Yoo, S.-K., You, S., & Wu, C.-C. (2010). The reciprocal relationship between parental involvement and mathematics achievement: Autoregressive cross-lagged modeling. *The Journal of Experimental Education, 78*(4), 419–439. https://doi.org/10.1080/00220970903292926

Hoover-Dempsey, K. V., & Jones, K. P. (1997). *Parental role construction and parental involvement in children's education*. Annual meeting of the American Education Research Association, Chicago.

Howard, J. L., Bureau, J. S., Guay, F., Chong, J. X., & Ryan, R. M. (2021). Student motivation and associated outcomes: A meta-analysis from self-determination theory. *Perspectives on Psychological Science, 16*(6), 1300–1323. https://doi.org/10.1177/1745691620966789

Howard, N. R., Howard, K. E., Busse, R. T., & Hunt, C. (2019). Let's talk: An examination of parental involvement as a predictor of STEM achievement in math for high school girls. *Urban Education*, 1–28, Article Unsp 0042085919877933. https://doi.org/10.1177/0042085919877933

Hu, L. t., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural equation Modeling: A Multidisciplinary Journal, 6*, 1–55. https://doi.org/10.1080/10705519909540118

Jeynes, W. H. (2007). The relationship between parental involvement and urban secondary school student academic achievement: A meta-analysis. *Urban Education, 42*(1), 82–110. https://doi.org/10.1177/0042085906293818

Jeynes, W. H. (2022). *Relational aspects of parental involvement to support educational outcomes: Parental communication, expectations, and participation for student success*. Taylor & Francis. https://doi.org/10.4324/9781003128434

Joussemet, M., Landry, R., & Koestner, R. (2008). A self-determination theory perspective on parenting. *Canadian Psychology/Psychologie canadienne, 49*(3), 194–200. https://doi.org/10.1037/a0012754

Kim, S. (2022). Fifty years of parental involvement and achievement research: A second-order meta-analysis. *Educational Research Review*, 37. https://doi.org/10.1016/j.edurev.2022.100463

Kline, R. B. (2023). Assumptions in structural equation modeling. In R. H. Hoyle (Ed.), *Handbook of Structural Equation Modeling* (2 ed., pp. 128–144). Guilford.

Kunnskapsdepartementet. (2007). *Kvalitet i skolen*. (Meld. St. nr. 31). Retrieved from https://www.regjeringen.no/contentassets/806ed8f81bef4e03bccd67d16af76979/no/pdfs/stm200720080031000dddpdfs.pdf

Kunnskapsdepartementet. (2020). *Læreplanverket*. Utdanningsdirektoratet. Retrieved 26.01.2024 from www.udir.no/laring-og-trivsel/lareplanverket

Little, R. J. (1988). A test of missing completely at random for multivariate data with missing values. *Journal of the American Statistical Association, 83*(404), 1198–1202. https://doi.org/10.1080/01621459.1988.10478722

Ma, X., & Kishor, N. (1997). Assessing the relationship between attitude toward mathematics and achievement in mathematics: A meta-analysis. *Journal for Research in Mathematics Education*, 26–47. https://doi.org/10.2307/749662

Mahuro, G. M., & Hungi, N. (2016). Parental participation improves student academic achievement: A case of Iganga and Mayuge districts in Uganda. *Cogent Education, 3*(1). https://doi.org/10.1080/2331186X.2016.1264170

Mansour, M., & Martin, A. J. (2009). Home, parents, and achievement motivation: A study of key home and parental factors that predict student motivation and engagement. *The Educational and Developmental Psychologist, 26*(2), 111–126. https://doi.org/10.1375/aedp.26.2.111

Martin, A. J., Way, J., Bobis, J., & Anderson, J. (2015). Exploring the ups and downs of mathematics engagement in the middle years of school. *Journal of Early Adolescence, 35*(2), 199–244. https://doi.org/10.1177/0272431614529365

Mata, M. d. L., Monteiro, V., & Peixoto, F. (2012). Attitudes towards mathematics: Effects of individual, motivational, and social support factors. *Child development research, 2012*, 1–10. https://doi.org/10.1155/2012/876028

McNeal Jr, R. B. (2014). Parent involvement, academic achievement and the role of student attitudes and behaviors as mediators. *Universal Journal of Educational Research, 2*(8), 564–576. https://doi.org/10.13189/ujer.2014.020805

Nordahl, T. (2000). *Samarbeid mellom hjem og skole - en kartleggingsundersøkelse* (8). NOVA.

Nordahl, T. (2007). *Hjem og skole: Hvordan skape et bedre samarbeid?* Universitetsforlaget.

Opsvik, F., & Skorpen, L. B. (2017). Utvikling av kartleggingsprøver i matematikk. In P. Haug (Ed.), *Spesialundervisning, innhald og funksjon* (Vol. 17, pp. 256–271). Samlaget.

Schreiber, J. B. (2002). Institutional and student factors and their influence on advanced mathematics achievement. *The Journal of Educational Research, 95*(5), 274–286. https://doi.org/10.1080/00220670209596601

Seah, W. T. (2008). Valuing values in mathematics education. In P. Clarkson & N. Presmeg (Eds.), *Critical issues in mathematics education: Major contributions of Alan Bishop* (pp. 239–253). Springer. https://doi.org/10.1163/9789087901509_013

Sheldon, S. B., Epstein, J. L., & Galindo, C. L. (2010). Not just numbers: Creating a partnership climate to improve math proficiency in schools. *Leadership and Policy in Schools, 9*(1), 27–48. https://doi.org/10.1080/15700760802702548

Soni, A., & Kumari, S. (2017). The role of parental math anxiety and math attitude in their children's math achievement. *International Journal of Science and Mathematics Education, 15,* 331–347. https://doi.org/10.1007/s10763-015-9687-5

Sonnenschein, S., & Dowling, R. (2019). Parents' socialization of their young children's interest in math. In O. N. Saracho (Ed.), *Contemporary perspectives on research on motivation in early childhood education* (pp. 75–100). Information Age Publishing, Inc.

Spates, J. L. (1983). The sociology of values. *Annual review of sociology, 9*, 27–49. https://doi.org/10.1146/annurev.so.09.080183.000331

Sujarwo, S., & Herwin, H. (2023). Parental involvement and student achievement: A meta-analysis of publications in the Scopus database. *International Journal of Instruction, 16*(2). https://doi.org/10.29333/iji.2023.1627a

Tabachnick, B. G., & Fidell, L. S. (2014). *Using multivariate statistics* (Vol. 6). Pearson.

Topphol, A. K. (2018). A correlation study of mathematics proficiency vs reading and spelling proficiency. *Nordic Research in Mathematics Education, 17*, 139–147.

Topphol, A. K., Haug, P., & Nordahl, T. (2017). SPEED-prosjektet, metode, datagrunnlag og prosedyrar. In P. Haug (Ed.), *Spesialundervisning, innhald og funksjon* (Vol. 17, pp. 31–51). Samlaget.

West, S. G., Taylor, A. B., & Wu, W. (2012). Model fit and model selection in structural equation modeling. In R. H. Hoyle (Ed.), Handbook of Structural Equation Modeling (pp. 209–231). Guilford.

Wigfield, A. (1994). Expectancy-value theory of achievement motivation: A developmental perspective. *Educational Psychology Review, 6*(1), 49–78. https://doi.org/10.1007/BF02209024

Wigfield, A., Eccles, J. S., Fredricks, J. A., Simpkins, S., Roeser, R. W., & Schiefele, U. (2015). Development of achievement motivation and engagement. In M. E. Lamb & R. M. Lerner (Eds.), *Handbook of Child Psychology and Developmental Science* (Vol. 3, pp. 657–700).

Wilder, S. (2014). Effects of parental involvement on academic achievement: a meta-synthesis. *Educational Review, 66*(3), 377–397. https://doi.org/10.1016/j.edurev.2018.02.001