Chapter 3
Student and/or Teacher Valuing in Mathematics Classrooms: Where Are We Now, and Where Should We Go?

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Abstract A seminal literature review of values in mathematics education was conducted at the turn of the century, and at that time revealed a paucity of research in this area (Bishop et al. in Values in mathematics teaching: The hidden persuaders? Dordrecht, The Netherlands: Kluwer Academic Publishers, 2003). Bishop and colleagues noted that a change in the values being taught is implicit in any recommendation for changing teaching, and argued that any significant development in mathematics education probably implies a change in values. Research in values in mathematics education remains a high priority today as STEM participation and achievement around the globe continues to encounter many challenges. This chapter presents an updated systematic literature review of values in mathematics classrooms with a view to identifying what has been achieved more recently in this field. Using a systematic search of peer-reviewed publications, some 299 abstracts met key term search criteria. Following an examination of the abstracts, a final data set of 34 studies were retained for further review and analysis. Research methodology, geographic location, stakeholder—teacher or student—valuing, age, grade level, gender, and a summary of original main conclusions were reported for each of the relevant studies. Results were synthesized across the data set to describe where the body of research is at currently.

Keywords Literature review · Mathematics · Students · Teachers · Values

3.1 Introduction

The study of values spans a broad multi-disciplinary terrain, with different disciplines pursuing the central concept of values from unique orientations. In the seminal literature on values in anthropology, Kluckhohn and Strodtbeck (1961) wrote that values can be conceptualized as being able to answer basic existential questions and to help

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provide meaning in people's lives. To social scientists, values are viewed as a means to help ease conflicts between collective and individual interests. Through this lens, values can be conceptualized as serving an important function in which individuals can work together to attain goals that are ascribed to by the collective group (Parsons and Shils 1951).

Although many definitions of values abound in the broader literature, unique meaning and role of values and valuing have been defined by the mathematics teaching and learning community. In his seminal discussion on culture and values in mathematics, Bishop (1988a) introduced six fundamental activities that he argued are universal, necessary and sufficient for the development of mathematic knowledge: *counting, locating, measuring, designing, playing,* and *explaining.* Subsequently Bishop (1988b) envisaged values as a variable of affect, and went on to describe six values that underpin the widely utilised notion of Western mathematics: *rationalism* and *objectism; mystery* and *openness; control* and *progress.*

At the start of the 21st Century the first literature review of values in mathematics education was conducted by Bishop et al. (2003). Reporting a dearth of literature, Bishop and colleagues noted that most empirical research was conducted within the five years prior to their review. In particular, the ARC Project *Values in Mathematics Project—VAMP* (1999–2002) was awarded to Bishop and Clarkson, whilst around the same time a parallel project led by Lin and colleagues was conducted in Tawain. Bishop and Clarkson reported that some studies covered in their literature analysed the values portrayed by text materials used in teaching mathematics. Other studies focused on mathematics classroom teachers, and on values-related activities within the classroom.

Bishop and colleagues (2003) attributed two main reasons for the paucity of research at the intersection of mathematics education and the values area. Firstly, the universalism of mathematics, in which mathematical concepts transcend language or geographic location together with the universal applicability of mathematical ideas, fosters the belief that mathematics is culture-free and therefore value-free knowledge. Bishop and colleagues explained that this universalism is one of the prime values underlying the "western" notion of mathematics that has gained pre-eminence in all parts of the world. Secondly, Bishop and colleagues described the long-held belief that mathematics teachers do not need to take social aspects of mathematics education into account in their teaching, which has resulted in the technique-oriented curriculum in which skill teaching and learning are the central focus. Bishop and colleagues reported that any significant development in mathematics education probably requires challenging these established beliefs. Accordingly, Bishop and colleagues argued the importance of taking values into consideration in future mathematics education research emphasizing that a change in the values being taught is implicit in any recommendation for changing teaching.

Initially, Seah and Bishop (2001) defined values in mathematics education as:

> … One's internalisation, cognitisation, and decontextualisation of affect variables (such as beliefs and attitudes) in one's socio-cultural context. They are inculcated through the nature of mathematics and through one's experience in one's socio-cultural environment and in the mathematics classroom. These values form part of one's ongoing developing personal

> value system, which equips one with a pair of cognitive and affective lenses to shape and modify ones way of perceiving and interpreting the world, and to guide ones choice of course of action. They also influence the development of one's other beliefs and ones needs in mathematics education and in life (p. 444).

Definitions of values in mathematics education have continually evolved since that time, with Seah (2018) most recently writing that:

> … valuing refers to an individual's embrace of convictions which are considered to be of importance and worth. It provides the individual with the will and grit to maintain any 'I want to' mindset in the learning and teaching of mathematics. In the process, this conative variable shapes the manner in which the individual's reasoning, emotions and actions relating to mathematics pedagogy develop and establish (Seah 2018, p. 575).

In earlier literature, values were viewed by Bishop as an affective variable. An important distinction between this and the current definition proposed by Seah is that values are viewed as a conative variable. In light of global diversity driven by modern migratory trends, in which students, teachers, and parents are submersed in new cultures, an "individual's embrace of convictions" is arguably of particular significance.

Science, Technology, Engineering, and Mathematics (STEM) form the backbone of our current global economies, with sectors such as education, engineering, food production, health care, infrastructure, manufacturing, research and development, supply chain, and transportation relying heavily on a STEM skilled workforce. Arguably, achievement in mathematics is vital to the adequate preparation of students to meet the technical needs of jobs of the future. However, falling rates of participation and achievement in STEM subjects has been widely acknowledged in Australia (Timms et al. 2018). Seah (2018) has highlighted the significant, though often overlooked, role of values in supporting the cognitive development and affective state of mathematics students. Accordingly, research in values in mathematics education remains a high priority. Common to any exploration of values, some form of measurement of the values held is necessary. Value measurement requires a questioning process through which themes are explored such as: what values are held by individuals?; how are various values prioritized?; and what variations or similarities in values may exist amongst cultures? are explored. In response to these challenges, and shaped by these value measuring aims, *The Third Wave Project* led by Seah commenced in 2009. At the time of this writing nearly all active researchers in the field of values in mathematics education have been invited to participate.

Primary sources of literature provide first-hand information on studies and includes detailed descriptions of the studies' methodology, data, analysis, results and findings. Although published in a variety of sources including journal articles, book chapters, dissertations, or conference papers, a review including all primary literature sources is beyond the scope of this chapter. As such, this current review has been restricted to peer-reviewed journal articles that arguably reflect the most current and complete studies that have undergone a rigorous review process. Presenting an updated systematic literature review of values in mathematics education, this study aims to provide a map of the empirical research conducted to date, and to

assist future researchers shape their exploration in values and valuing in mathematics education. The following research questions were developed:

i. Where has research been conducted?
ii. Which stakeholders are represented in the research?
iii. What is known about the development of values?
iv. How consistent are the findings reported in the studies?

3.2 Systematic Search Procedure

The What Works Clearinghouse (WWC) Procedures Handbook Version 4.0 has been developed by the U.S. Department of Education's Institute of Education Science (IES) to facilitate a systematic literature review process that uses consistent, objective, and transparent standards and procedures (WWC Procedures Handbook V4.0, 2017). The WWC review process comprises five steps: developing the review protocol to define the parameters for the research to be included in the review; identification of relevant literature; screening studies; reviewing studies; reporting on findings. While values research in mathematics education is a relatively young field, the WWC systematic review framework was adopted for this current chapter to provide a replicable procedure for future researchers working in this field.

Studies were located by conducting a systematic search of peer-reviewed literature published between January, 2003 and March, 2018. Both the PsycINFO and ERIC databases were queried using the search terms *math** AND *valu**. The abstract of each article was examined to determine whether an article was likely to meet inclusion criteria for further review, and a review of the full article was conducted when further clarification was necessary. Inclusion criteria required that:

1. The study reported on mathematics "teaching" or "learning" for students studying at primary or secondary levels
2. The study reported empirical data that may have been gathered from: classroom work; project work; homework; assessments; classroom observations; field notes
3. The study reported on either teacher, student, or parent/guardian valuing
4. The study investigated values alone, or in conjunction with other components of mathematics education such as test anxiety, personality, and/or beliefs
5. The full article was published in English in a peer-reviewed journal.

The psycINFO database search identified 109 abstracts that met search term criteria. Following examination of each abstract, 67 articles were retrieved for further clarification. Of the 52 studies that met the inclusion criteria (see 5 points above) for this review, 21 were published before 2003 and thus omitted from further review. Two journal articles—that is, Dede (2006) and Eklof (2007)—were unable to be located and were subsequently omitted from further review.

The ERIC database search identified 190 abstracts that met search term criteria. Following examination of each abstract, 16 articles were retrieved for further clarification to determine adherence to inclusion criteria as the abstract alone provided

insufficient information about the study. Three studies from the USA, one study covering both the UK and Canada, one study from Malaysia, and one study from Africa studies did not include empirical data and thus were omitted from further review. One study from Taiwan provided data for science rather than mathematics, and was also omitted from further review. One study that explored values in Hawaii was unable to be located either in the university library or elsewhere (Furuto 2014), and was omitted from further review.

3.3 Results and Discussion

The search and study inclusion procedure identified 34 studies that reported on a variety of stakeholder perspectives as they relate to values and valuing in mathematics education. The Appendix provides a descriptive overview of each study included in the review. The number of annual publications were plotted in the line graph depicted in Fig. 3.1. The trend line indicates a positive growth in publication volume, reflecting the growing interest by researchers in this field.

3.3.1 Where Has Research Been Conducted?

Studies were conducted by 30 research teams, of which two studies are affiliated with the Third Wave Project (Dede 2013a, b). The studies presented in this review were conducted in 14 countries: *Australia (1), Canada (3), Finland (1), Germany (12), Greece (2), Hong Kong (1), Israel (1), Norway (2), Singapore (1), South Africa (1), Sweden (1), Taiwan (2), Turkey (3),* and *USA (7),* as depicted in Fig. 3.2. Of these, multiple-site study data was collected in Germany, Canada, and Israel (Boehnke 2005), and Greece and Turkey (Dede 2013a, b). One study analyzed data from 60 nations and presented meta-level findings with country specific findings not described individually (Fang et al. 2016).

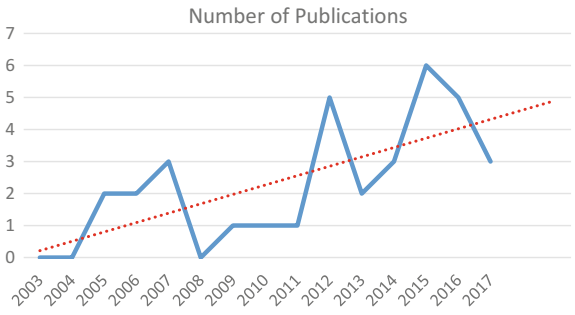

Fig. 3.1 Frequency of publications

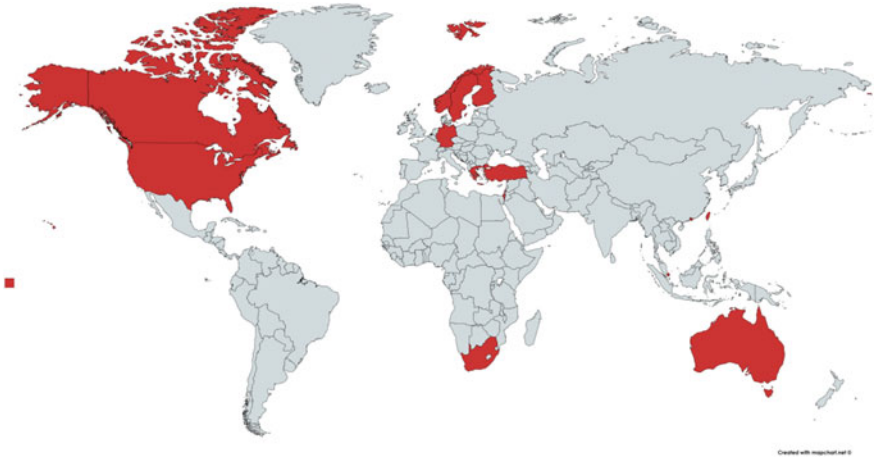

Fig. 3.2 Map of the countries that studies have been conducted in

3.3.2 Which Stakeholders Are Represented in the Research?

While studies primarily collected data directly from the students, teacher data (Chouinard et al. 2007; Dede 2013a, b; Diemer et al. 2016; Federici and Skaalvic 2014; Haara and Smith 2012; Leu 2005; Metallidou and Vlachou 2010; Peng and Nyroos 2012), parent perspectives (Gniewosz and Noack 2012; Chouinard et al. 2007), and peers (Bissell-Havran and Loken 2009) were occasionally included. A total of 152,500 student participants were included in the 34 studies.

Student participants ranged from 7.5 to 18 years. The majority of studies focused on students who have reached adolescence rather than students in their early years. Two articles reported on a longitudinal studies that tracked students from Grade 6 until Grade 12 (Wang 2012), and from Grade 3 until Grade 12 (Simpkins et al. 2006).

3.3.3 What Is Known About the Development of Values?

Factors that may influence the development of values was a common theme amongst the studies. In particular, student-perceived ability was frequently examined, noted in five studies (Gniewosz and Watt 2017; Viljarants et al. 2016; Diemer et al. 2016; Gaspard et al. 2015; Metallidou and Vlachou 2010). One study reported on the development of student values in mathematics as a function of maternal and paternal values in mathematics (Gniewosz and Noack 2012), one study reported on the supportive role of peers and students perceptions of their peers valuing in mathematics (Bissell-Havran and Loken 2009), and one study reported on the influence of mathematics classroom experiences over the development of students values (Wang 2012). One

study examined the profile of a resilient learner who has succeeded in mathematics despite adversity, and described a female learner in which the language of classroom instruction was not spoken at home, who places a high value on mathematics (Frempong et al. 2016).

The utility of modelling activities compared to traditional problems solving and the subsequent impact of the development of student values was reported in two studies (Dorak 2012; Haara and Smith 2012). The role of values in relation to mathematics anxiety was explored in one study (Henschel and Roick 2017), in relation to the prediction of motivation and effort in mathematics was explored in five studies (Andersen and Cross 2014; Berland and Steingut 2016; Federici and Skaalvik 2014; Hsiang 2017; Penk and Schipolowski 2015) and more specifically in relation to effort in mathematics homework in one study (Trautwein et al. 2006).

One study examined self-regulated strategy use in elementary mathematics and specifically considered the role of student valuing in this context (Chatzistamatious et al. 2015). The authors reported that enjoyment and positive valuing of the importance of mathematics as a school subject are necessary for mastery goals to have a positive effect on students' use of self-regulated strategies in mathematics. Elsewhere, the relationship between self-concept and utility values in the prediction of educational outcomes, including persistence in mathematics, was reported in three studies (Guo et al. 2015; Andersen and Ward 2014; Fries et al. 2007). One study reported that the relationship between achievement value and academic achievement performance was not overly strong and suggest that achievement values may play an ambiguous role in generating high academic performance (Boehnke 2005).

3.3.4 How Consistent Are the Findings Reported in the Studies?

Gender was explored in five studies, with two studies describing gender differences (Henschel and Roick 2017; Gaspard et al. 2015) and three describing consistency in findings for both genders (Muis et al. 2015; Guo et al. 2015; Simpkins et al. 2006). One study specifically described omitting special needs students from their data (Penk and Schipolowski 2015), one study noted that 30% of the students had an Individualised Education Plan (IEP) (Muis et al. 2015), and one study included one general education class and one special education class (Peng and Nyroos 2012). Difference in values held by general education students when compared to students in special needs education was described in one study (Peng and Nyroos 2012).

3.4 Conclusion and Implications

The aim of this study was to provide a mapping of the empirical research that has been conducted to date, and to use the research findings to inform the evolving definition of values in mathematics education. Findings from the data set as a whole suggest that the role of students' levels of motivation and effort are of prime importance to understanding student values in mathematics. Developing an understanding of how students perceptions of their mathematical abilities impact their valuing has been given almost equal attention in the research. The utility value of mathematics, and how this relates to student valuing has been frequently investigated. The most frequently represented countries in the data set are Germany and the USA.

Although the majority of studies included high school students, research conducted in lower grade levels has suggested students with higher cognitive ability and greater motivation hold high value beliefs in mathematics (Metallidou and Vlachou 2010), and that positive value beliefs are necessary for mastery goals to be effective (Chatzistamatiou et al. 2015).

Drawing upon the current findings, it appears that there is general agreement that suggests that values are a reflection of motivation and effort largely shaped by perceived ability. Additionally, the role of perceived utility appears central to the subsequent values held by the individual. When considered using the traditional theory of psychology, the classic partition of the mind is viewed in terms of three functions: cognition, emotion, and conation—the will or volitional component that drives an individual in his or her application to a given task. To date it appears that values researchers have explored cognition, and emotion largely operationalizing the investigations in terms of ability, achievement, self-concept, motivation and effort. Less is currently known about the role of conation in shaping values.

In contrast to frequent reports of the significance of positive valuing of high achievement in relation to favourable academic performance outcomes, the exploratory study conducted by Boehnke (2005) has highlighted a weak relationship. More specifically, Boehnke has explained that the impact of achievement values on performance is always indirect, elaborating that such valuing infact impact achievement related self-esteem. Boehnk demonstrated a two-field influence of achievement value on grades arguing both a positive and negative impact on achievement related self-esteem. While noting the line of research as exploratory, Boehnke has alerted educational researchers to the possibly ambiguous role achievement values play in the generation of high academic performance. Further, inconsistent findings are included in this data set regarding the role of gender differences in relation to values in mathematics.

To date little research investigating changes in values in mathematics teaching and learning has been conducted, either across time or as environmental changes attributed to migratory and immigration trends occurs. One large group study conducted in Taipei, Singapore, and America across both Grade 4 and Grade 8 reported that student values and competence beliefs decrease over time (Hsiang-Wei 2017). More specifically, we can understand this to mean that the less students like mathe-

matics over time, the less they believe they are competent in this subject, and deduce that their positive valuing of mathematics as a subject decreases. Ongoing research conducted across time intervals, and in a variety of location appears highly warranted, to better identify patterns in changes in valuing and subsequently develop intervention strategies aimed to promote optimal outcomes in student mathematics achievement.

Immigration trends around the world has meant that many families are relocating to new countries. Research into whether existing values in mathematics education are retained, or new values developed is one important line of query. In particular, questions arise regarding whether opportunities in new environments are able to be accessed by newly arrived families, and do these new settings contribute to positive associations with studying mathematics.

The main data collection method utilized by these studies has been a self-report questionnaire instrument, of either student or other stakeholder measures. Few studies have included other data sources, such as classroom observations or interviews, and even fewer studies have included multiple stakeholder responses. Few longitudinal studies have been conducted (Muis et al. 2015; Simpkins et al. 2006). Further, there is a paucity of research that has adopted a pre- and post- assessment of valuing in conjunction with mathematics classroom teaching intervention, skill-building intervention, or home-work intervention. Future research that addresses these knowledge gaps appears highly warranted.

Countries around the world are encountering multi-culturism in new ways. With this comes new challenges to mathematics education, and arguably the field of values is increasingly pertinent to successful teaching and learning of mathematics. Many students face tremendous challenges before entering the mathematics classroom – language barriers, ethnic or racial tension, economic hardship to name but a few. In these instances, it is increasingly important to address a variety of factors in the broader environment that may impact experiences inside the mathematics classroom. Values would be one of these factors, given that these are often shaped externally in the societies and communities in which the students operate, but espoused in the classrooms as the students negotiate on a day-to-day basis the border crossings between home and school.

A significant limitation of this review is that only English language publications have been included. Many values researchers are active throughout Asia, and publications in various languages exist. A recent study by Peng and Nyroos (2012) published in Korean in The Mathematical Education journal of the Korean Society for Mathematics Education is one such example.

Appendix: Summary of Studies

Authors	Year	Sample size	Year level	Mean age	Gender	Setting	Location	Aim of study	Data collection	Findings
Gniewosz and Watt	2017	n = 398 n = 414 n = 459 N = 1,271	Grade 7–10	13.25 years 12.36 years 14.41 years	44.9% girls 43.6% girls 42.9% girls	Upper middle-class coed secondary school; 3 cohorts	Sydney, Australia	Student perceptions of parents and teachers' overestimation of ability	Mathematical task values: intrinsic and utility	Perceived encouragement conveyed by student-perceived mathematical ability beliefs of parents and teachers promote positive mathematics task values development
Henschel and Roick	2017	N = 368	Grade 4	9.4 years	52% girls	Elementary school	Germany	Value of learning and studying mathematics for its own sake	Intrinsic domain value—6 questions; Extrinsic achievement value—3 questions	1. Anxieties correlate stronger with control beliefs than domain values; 2. Achievement values not related with anxiety; 3. Girls reported lower intrinsic values; 4. No gender differences achievement outcomes

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Authors	Year	Sample size	Year level	Mean age	Gender	Setting	Location	Aim of study	Data collection	Findings
Hsiang-Wei	2017	N = 44,667	Grade 4 and 8	10–14		TIMMS 2011 database	Taipei, Singapore, America	Effect of motivation and engagement on achievement	Motivational framework including intrinsic value	Students' values and competence beliefs decrease over time
Berland and Steingut	2016	N = 113	K–12	n/a	n/a	8 schools—Engineer Your Word 2012–2013	South Central USA	How student perceptions of value of math and expectancy for success relate to effort	Survey of expectancy, value and effort towards mathematics and science in engineering design challenges	Subjective task value was found to significantly predict effort towards mathematics Researchers argue the need for educators to help students to recognize the value of each domain within STEM environment
Diemer, Marchand, McKellar, and Malanchuk	2016	MADIS Wave 3 N = 618	End of Grade 8	n/a	45.6% girls	23 Public middle schools; African-American sample	Prince George County, Maryland, USA	Relevant instruction, self-concept of ability, task value, and achievement	Teachers' differential treatment: 1item of questionnaire measure youths' mathematics task value (expectancy-value framework)	Findings suggested that self-concepts of ability are predictive of task value and play a role in achievement over time

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Authors	Year	Sample size	Year level	Mean age	Gender	Setting	Location	Aim of study	Data collection	Findings
Fang, Xu, Grant, Stronge and Ward	2016					TIMMS 2011 data	60 Counties	Relationship between national culture, creativity	World Values Survey (WVS)—traditional/secular and survival/self-expression dimension	Countries high on secular dimension performed higher on TIMMS student achievement Countries high on self-expression outperformed those high on survival
Frempong, Visser, Feza, Winnaar, and Nuamah	2016	N = 11,969	Grade 9			298 Schools; refined to public schools only	South Africa	Explored what drives the success of resilient learners	TIMMS 2011 public schools; explored gender, how often test language spoken at home, students' attitudes, bullying, parent education level, homework	Identified typical resilient learner: girl who does not speak classroom instruction language at home, tends to value and like mathematics and expressed confidence about their ability to learn mathematics
Viljaranta, Aunola, and Hirvonen	2016	N = 156	Grade 1	7.5 years	79 boys 77 girls	Three schools	Northern Finland	Children's intrinsic value, self-concept of ability, performance	Interview using Task-Value Scale for Children	Five groups: positive, negative, math-motivated, reading-motivated, low intrinsic value but high belief. Motivational patterns associated with students' level of performance at start and throughout grade 1

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Authors	Year	Sample size	Year level	Mean age	Gender	Setting	Location	Aim of study	Data collection	Findings
Chatzistamatiou, Dermitzaki, Efklides, and Leondari	2015	N = 344	Grade 5 and Grade 6	11–12 years	163 girls 181 boys	Elementary school (medium socio-economic status)	Greece	Self-regulatory strategies, achievement goals, self-efficacy, value, enjoyment	Value: three items assessed students value beliefs about importance of mathematics	Results showed that students' positive self-efficacy, value beliefs, and enjoyment of mathematics are necessary for mastery goals to have a positive effect on mathematics strategy use
Gaspard, Dicke, Flunger, Brisson, Hafner, Nagengast, and Trautwein	2015	N = 1,916	Grade 9	14.62 years	53.5% girls	25 Academic-track Gymnasium schools, 82 classrooms	Baden-Wurttenberg, Germany	Relevance intervention in the classroom, assessment based on Expectancy-Value theory	37 items addressed all four components of EVT: Intrinsic value 4 items, Attainment value 10 items, Utility value 12 items, Cost value 11 items	Classroom intervention assessed via self-reports Compared to control comparison, classes in the quotation condition reported higher utility value, attainment value, and intrinsic value and classes in the text condition reported higher utility value

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Authors	Year	Sample size	Year level	Mean age	Gender	Setting	Location	Aim of study	Data collection	Findings
Gaspard, Dicke, Flunger, Schreier, Hafner, Trautwein, and Nagengast	2015	N = 1,868	Grade 9	14.62 years	53.3% girls	25 Academic-track Gymnasium schools, 82 classes	Baden-Wurttenberg, Germany	Gender differences: Expectancy-Value Theory: attainment value, intrinsic value, utility value, cost	37 items addressed all four components of EVT	Conceptual differences of value beliefs, achievement, personal importance, utility, effort, emotional cost and opportunity cost. Mean differences favoured boys
Guo, Marsh, Parker, Morin, and Yeung	2015	TIMMS 1999 5,179 2003 4,972 2007 3,470	Grade 8	14.4 years	49.3% girls (1999) 50.4% girls (2003, 2007)	Stage 1: schools Stage 2: classroom selected from stage 1	Hong Kong	Expectancy-Value, gender, and socio-economic background as predictors of achievement	TIMSS scale of students' positive affect (intrinsic value) and TIMSS scale of students valuing (utility value); academic achievement, educational aspirations, background	Self-concept and lower utility values predictive of outcomes, boys' and girls' similar levels of self-concept and values, girls' higher achievement and educational aspirations, socioeconomic status linked to aspirations for boys

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Authors	Year	Sample size	Year level	Mean age	Gender	Setting	Location	Aim of study	Data collection	Findings
Muis, Psaradellis, Lajoie, Di Leo, and Chevrier	2015	N = 79 (30% students had IEP)	Grade 5	11 years	34 girls 45 boys	Eclectic mix of low—high income families	Canada	Prior knowledge, emotions, task values, academic control, activity	Task value measured at four points in time, used to measure students value in learning mathematics in general as well for problem solving	No gender differences found for task value. Perceived control and value served as important antecedents to the epistemic and activity emotions students experience during problem solving
Penk and Schipolowski	2015	N = 42,298	Grade 9	15.6 years	49.8% girls	Nationally representative sample excluding special ed students	Germany	Test taking motivation questionnaire (pre-post achievement test)	Values measured: Importance, Interest, Anxiety	Value component more important than expectancy component for prediction of effort. When viewed together value and effort taken explained over a quarter of the variance in mathematics scores

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Authors	Year	Sample size	Year level	Mean age	Gender	Setting	Location	Aim of study	Data collection	Findings
Andersen and Cross	2014	N = 19,259 after missing data omitted	Grade 9	n/a	n/a	944 public and private schools, 27 students per school	10 states across USA	Explored whether high ability students are more motivated than other students	National Center for Education Statistics Expectancy-value theory: achievement, self-efficacy, attainment value, utility value, interest-enjoyment	Identified high self-efficacy with lower utility value and high utility value with lower self-efficacy. 41% of high-ability students had high motivation, 15% of high-ability students had low motivation
Andersen and Ward	2014	n = 221 Black n = 351 Hispanic n = 1,185 White N = 1,757	Grade 9	n/a	123 girls; 180 girls; 546 girls	944 public and private schools, 27 high ability students per school;	10 states across USA	Comparison of STEM persistence plans of high-ability Black, White, and Hispanic students	Expectancy-value scale: self-efficacy, identity; attainment scale: utility value 4 items, intrinsic value 4 items, cost value 4 items in mathematics and science	Black: persisters significantly higher than non-persisters in achievement value. Hispanic: persisters significantly higher than non-persisters in STEM utility value; White: persisters scored significantly higher than non-persisters in mathematics attainment value

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Authors	Year	Sample size	Year level	Mean age	Gender	Setting	Location	Aim of study	Data collection	Findings
Federici and Skaalvik	2014	N = 309	Grade 9 and 10	n/a	51.8% girls 48.2% boys	Two middle schools 3 classes Grade 9 5 classes Grade 10	Large city in Norway	Subjective task values in relation to students' perceptions of teacher support and student effort	Norwegian language instrument: teacher instrumental support—7 items, utility value—5 items, cost value—3 items, intrinsic value—6 items, effort—3 items	Instrumental support directly positively related to utility and intrinsic value but only indirectly related to perceived cost value of mathematics. Where instrumental support was indirectly related to effort the relation was mediated by students' perceptions of task values
Dede	2013 (a)	N = 22	Primary and Secondary	n/a	n/a	13 German teachers; 9 Turkish teachers	Northern Germany; Central Anatolia, Turkey	Explored underlying values of Turkish and German mathematics teachers	Values in Mathematics Teaching in Turkey and Germany (VMTG): semi-structured interviews and field notes	Identified four values categories: Productivity, socialization, flexibility/authority, gender differences. Gender differences more important to German teachers; Turkish teachers attached great importance to student productivity

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Authors	Year	Sample size	Year level	Mean age	Gender	Setting	Location	Aim of study	Data collection	Findings
Dede	2013 (b)	N = 60	Primary and Secondary		24 Female 26 Male	27 German teachers; 33 Turkish teachers	Berlin (27) Sivas (31) Ankara (2)	Does mathematics teachers experience and nationality influence values	Five point likert type questionnaire	Teaching experience between the countries has a significant effect on the values, and both Turkish and German mathematics teachers' level of experience does not have a significant impact on their values
Doruk	2012	n = 34 grade 6 n = 24 grade 7 N = 58	Grade 6 and 7	n/a	28 boys 30 girls	Primary school low socio-economic status	Ankara, Turkey	Processes that teach mathematics and educational values	Researcher observations, student worksheets, videos, reports and semi-structured interviews; thematic analysis: general education values; mathematics values	Student development of models, defending functionality and discussion effective for developing responsibility values. Integration of teamwork and communication develop social and cultural values

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Authors	Year	Sample size	Year level	Mean age	Gender	Setting	Location	Aim of study	Data collection	Findings
Gniewosz and Noack	2012	n = 874 mothers n = 733 fathers	Grade 5 and 6	10.6 years and 12.1 years	49.1% male, 47.4% male	15 regelschule and 15 gymnasium schools; 60 classrooms	Thuringen, Germany	Intergenerational transmission of the valuing of mathematics within family	Student and parent questionnaire at two time points: beginning Grade 5 and mid Grade 6; measured attainment value, intrinsic value, utility value	Group 1 mothers valuing predicted students' own mathematics values; Group 2 fathers valuing predicted students' own valuing of mathematics. Dyad gender predicted group membership
Haara and Smith	2012	N = 2	Grade 4 and Grade 8 teachers	9—10 years and 13—14 years	n/a	Upper primary school and Lower secondary school	Norway	In-service course to introduce a values-based approach to teaching	interviews, videos of observation and teachers' reactions to their videos, logs, open-ended questionnaire	VaKE provided opportunity for increased use of practical teaching activities, but also showed how good intentions of changing practice may be restrained by beliefs and prior experiences

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Authors	Year	Sample size	Year level	Mean age	Gender	Setting	Location	Aim of study	Data collection	Findings
Peng, and Nyroos	2012	N = 2	Grade 7 and 8	n/a	n/a	Prestigious city school; general ed and special ed classrooms	Northern Sweden	What is valued by students in each group, what is valued by teachers in each group	Lesson observations, student focus group interviews, and teacher interviews	General Ed students three most cited values: explanation, quietness, and personalised help; Special Ed students three most cited values: independence, relaxation, and explanation
Wang	2012	N = 14,236	Data collected at five time points	Grade 7: 12.4 years	54% female (G7)	124 mathematics classrooms drawn from 12 public schools	Southeastern Michigan, USA	Predictors of student choices to enroll in highschool, and mathematical occupational aspirations	Grades, number of courses, aspirations, motivational beliefs: expectancies—5 items, subjective task values i. importance—3 items ii. Interest—3 items,	Mathematics classroom experiences predicted expectancies and values, which in turn predicted the number of high-school mathematics courses taken and students career aspirations in mathematics related areas

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Authors	Year	Sample size	Year level	Mean age	Gender	Setting	Location	Aim of study	Data collection	Findings
Yazici	2011	N = 359	Pre-service teachers	Primary and Secondary			Turkey	Pre-service teachers' mathematical values and their teaching anxieties	Mathematics Teaching Anxiety Scale—23 items; Mathematics Values Scale—34 items (Positivist values and Constructivist values)	Constructivist value preferences of pre-service teachers directly affect their mathematics teaching anxieties; no significant relationship between positivist values and mathematics teaching anxiety
Metallidou and Vlachou	2010	n = 114 Grade 5 n = 149 Grade 6	Grade 5 and Grade 6	10 years 7 months and 11 years 9 months	133 girls 130 boys	13 public primary schools,	Greece	Explored the role of task-value beliefs in childrens' self-regulated learning	Task-value beliefs—9 items, self-efficacy, test anxiety. Teacher ratings of student achievement, meta-cognitive knowledge, student self-regulation	Students with high value beliefs in mathematics were described as more cognitively, metacognitively, and motivationally competent learners as compared to students with lower value beliefs

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Authors	Year	Sample size	Year level	Mean age	Gender	Setting	Location	Aim of study	Data collection	Findings
Bissell-Havran and Loken	2009	n = 207	Grade 8	13 years	114 boys 113 girls	Rural school, 21% economically disadvantaged	Mid-Atlantic, USA	Explored the role of friendships in academic self-competence and intrinsic values in Mathematics	Measures: friends support, intrinsic values for English and Mathematics—4 items (each), academic self-competence	Analyses predicting intrinsic value for mathematics and English provided weaker evidence of an interaction. Students also perceived that their friends valued academics significantly less than the friends actually reported
Chouinard, Karsenti, and Roy	2007	N = 759	Grade 7 – 11	12–18 years	389 boys 370 girls	4 public highschools	Montreal, Canada (French speaking)	Relationship between the beliefs, utility value and achievement goals	Confidence—6 items, utility—5 items, mastery—8 statements, performance—6 statements, work-avoidance—6 statements; effort—3 items	Mastery goals had significant impact on student's effort in learning mathematics. Competence beliefs, utility value, achievement goals and effort not significantly influenced by age and gender

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Authors	Year	Sample size	Year level	Mean age	Gender	Setting	Location	Aim of study	Data collection	Findings
Frenzel, Pekrun, and Goetz	2007	n = 2,053	Grade 5	11.7 years	1,036 boys 1,017 girls	42 schools mix of socio-economic and cultural background	Bavaria, Germany	Gender difference in emotion towards mathematics	Measures: competence belief, value belief, mathematics emotions and mathematics grades	Girls reported significantly less enjoyment and pride, more anxiety, hopelessness and shame. Female emotional pattern due to the girls' low competence beliefs and domain value and high achievement value
Fries, Schmid, and Hofer	2007	N = 704	Grade 6 and 8	13.5 years	48.4% boys 51.4% girls	9 schools from all 3 school types 29.5% immigrant	Ludwigshafen, Germany	Relationship between value orientations, valences, and academic achievement	Similarity to students prototypes for achievement value and well-being value; Intrinsic incentives—4 items, extrinsic incentives 4 items; Actual grades	Results showed that school grades were significantly predicted by value orientation
Simpkins, Davis-Kean, and Eccles	2006	N = 227	Longitudinal data Grade 5, 6, 10, 12	8.33 years Grade 3	54% girls	12 public schools from three school districts	Michigan, USA	Mathematics/science choices and beliefs from child-hood—adolescence	Expectancy-value at Grade 6 and 10	Youths' mathematics and science activity participation predicted their expectancies and values which in turn predicted the number of high school courses taken No gender differences

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Authors	Year	Sample size	Year level	Mean age	Gender	Setting	Location	Aim of study	Data collection	Findings
Trautwein, Ludtke, Kastens, and Koller	2006	Study 1 N = 2,712	Grade 5, 7, 9	13.37 years	49.5% girls	158 classes representing 11 schools	Large city in Germany	Age-related differences in students mathematics homework	Measures: homework effort—4 items; expectancy-value using self-concept of ability and intrinsic value—5 items; conscientiousness	Lower homework effort in higher grades. Intrinsic value on homework effort were higher in the older cohorts, whereas effects of the expectancy component were lower
		Study 2 N = 571	Grade 8 and 9	14.72 years	51.5% girls	44 classes from 10 schools	Large city in Germany	Power of motivation to predict effort	Effort—6 items; concentration—3 items; motivation—3 items, value—3 items; control—3 items, adaptability—3 items	Means for effort and value were lower for homework than for classwork with these differences being partly moderated by the students' conscientiousness

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Authors	Year	Sample size	Year level	Mean age	Gender	Setting	Location	Aim of study	Data collection	Findings
Boehnke	2005	Germany n = 641 Canada n = 605 Israel n = 419 N = 1,665	Grade level not specified	14 years	Germany 336 girls Canada 301 girls Israel 205 girls	Germany 14 schools; Canada 4 schools; Israel 2 schools	Chemnitz, East Germany; Calgary, Canada; and Beer-Sheva, Israel	Explored the role of achievement value in mathematical achievement as measured by school grades and test scores	Measures:—most recent mathematics report grades, independent assessment using TIMSS; self-esteem—9 items; manifest anxiety—6 items; parental achievement expectancies—3 items; achievement value preferences—4 items	Relationship between achievement value and academic achievement performance as a behaviour measure is not overly strong. Findings proposed as a means to alert educational researchers to the possibly ambiguous role of achievement values in generation of high academic performance
Leu	2005	N = 1	Elementary mathemat-ics	n/a	17 girls, 19 boys; 1 teacher	Teachers college affiliated Laboratory School	Taipei, Taiwan	Teachers pedagogical values and her students' perceptions	Weekly lesson observation; Observation of complete unit of instruction (geometry); occasional and intermittent observations	Goal of education; value of dealing with people and life; value of mathematics learning; value of mathematics teaching; value of mathematics education

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