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
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 val-
ues 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. Sub-
sequently 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 Taiwan.
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 edu-
cation 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 col-
leagues 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 edu-
cation 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 one's way of perceiving and interpreting the world, and to guide one's choice of course of action. They also influence the development of one's other beliefs and one's 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 submerged 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
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 Skaalvik 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).
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 in fact impact achievement related self-esteem. Boehnke 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-
Mathematics 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      | Grade 7–10 | 13.25 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 | (continued)
| 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: 1 item 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 |

(continued)
| 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    |          |        |         | 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 |
| 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-Württemberg, Germany | Relevance intervention in the classroom, assessment based on Expectancy-Value theory | 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 |
| 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    | 53.3%  | 25 Academic-track Gymnasium schools, 82 classes                        | Baden-Württemberg, 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 | Grade 8    | 14.4     | 49.3%  | 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 |

(continued)
3 Student and/or Teacher Valuing in Mathematics Classrooms

| 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 |
| 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 | 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 | (continued)
| 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 |

(continued)
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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% female | 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 |
| 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 personalized help; Special Ed students three most cited values: independence, relaxation, and explanation |
| Wang                           | 2012 | N = 14,236  | 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 | (continued)
| Authors                      | Year  | Sample size | Year level | Mean age | Gender | Setting          | Location | Aim of study                                      | Data collection                                                                 | Findings                                                                 |
|-----------------------------|-------|-------------|------------|----------|--------|------------------|----------|--------------------------------------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| Yazici                      | 2011  | N = 359     | 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 children's 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 |

(continued)
| 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 high schools | 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 |
| 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 emotions 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 girls' low competence 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     | Grade 3, Grade 5, Grade 6, Grade 12 | 8.33 years | 54% girls | 12 public schools from three school districts | Michigan, USA | Expectancy-value at Grade 6 and 10 | Mathematics/science choices and beliefs from childhood to adolescence | Youth's mathematics and science activity participation predicted the number of high school courses taken. No gender differences. |
| 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 |
### Authors

| 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 mathematics | 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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