EXPLORING PERCEIVED VALUE DIFFERENCE SITUATIONS IN AUSTRALIAN MATHEMATICS CLASSROOMS

Anni E and Wee Tiong Seah

Faculty of Education, The University of Melbourne, Australia

Recent research has highlighted how students might disengage from classroom activities when their values and their teachers' are different. The present study examined 625 secondary school students' perspectives and experiences to better understand what these value difference situations look like. Analysis of the 29 identified instances of value differences revealed the need to propose a new category - mathematical content value – to add to the existing classification of values. The findings reveal an issue where students often struggle to appreciate the value of learning specific mathematical content, even when teachers emphasise its practical usefulness. The results also highlight that teacher' excessive reliance on textbooks runs counter to student' mathematics educational values, hindering their learning.

INTRODUCATION

Previous research (Seah & Andersson, 2015) revealed how students and teachers bring their personal values (that is, regarding what is important) in mathematics education into the classroom. Since individuals' values in mathematics education stem from the nature of mathematics as well as their sociocultural and educational experiences (Seah, 2019), students and their teachers develop and interpret these values in diverse ways. This phenomenon becomes more complex in multicultural societies such as in Victoria, Australia, where teachers, students and families hail from a diverse ethnic and racial profile. It is thus reasonable to assume that interactions in the (Victorian) mathematics classroom is characterised by the coming together of a range of teacher and student values relating to mathematics, mathematics teaching and learning, and education generally.

Given that decisions and actions (in mathematics education) are driven by values (Seah, 2019), the alignment of students' values with their teacher's influences the quality of classroom interactions, and thus, of the lessons. For instance, a teacher who values *group work* would incorporate collaborative activities in their lessons, but any of their students valuing *independent work* might disengage with or avoid such activities. Indeed, students who hold different values from their teachers are likely to resist or disengage, negatively affecting their interest and performance in mathematics learning (Kalogeropoulos, 2016). Effective teaching thus requires an understanding of value differences, as teacher intentions alone are unlikely to ensure successful lessons. This calls for a thorough exploration of the attributes valued by students and their teachers in mathematics pedagogy.

2024. In T. Evans, O. Marmur, J. Hunter, G. Leach, & J. Jhagroo (Eds.). *Proceedings of the 47th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 2, pp. 184–191). PME.

Previous studies assumed that students would express their values through feedback to their teachers (Kalogeropoulos et al., 2021). However, students may conceal their values for a variety of reasons. Even when students have choices, these choices are usually constrained within the classroom context (Clarkson et al., 2019). Thus, to gain a more comprehensive understanding of value differences in the mathematics classroom, it is important to consider whether students are able to contemplate, compare, and express their values during classroom interactions. In this context, the current study seeks to address this gap, establishing a comprehensive overview of the types of value differences in mathematics classrooms, based on Victorian students' perspectives.

The Research Question guiding our study here is: What sorts of values espoused by students and their teachers most often end up in value difference situations?

THEORETICAL FRAMEWORK

Instead of being viewed as an objective body of knowledge awaiting discovery, mathematics has been acknowledged as being socialised knowledge (Bishop, 1988). Research into values and valuing in mathematics education from the late 1980s (see Bishop, 1988, 1996) acknowledges that the discipline and its pedagogy is culture-dependent. Early research literature in this area reflects a conception of values as an affective variable (Bishop, 1996). Seah (2019), inspired by the tripartite model of the human mind, later redefined values as being conative in nature. In doing so, Seah could explain why people often passionately embrace their values and why values can be made visible through decision processes. Hence, this study adopted Seah's (2019) definition of values in mathematics education, in which valuing is concerned with "an individual's embracing of convictions in mathematics pedagogy...[shaping] the individual's willpower to embody the convictions in the choice of actions" (p. 107). Since a value directs an individual's course of action, values can be regarded as being motivational (E, 2023). However, motivation might not fully explain persistence—the character of will and determination embedded in values empower determination amid obstacles (Seah & Andersson, 2015), not just guiding actions but defending them. As such, value difference situations arising from interactions between teachers and students are characterized not just by motivation, but also involve the will inherent in values.

Bishop's (1996) categories of values in mathematics education, namely, general educational, mathematical, and mathematics educational values, provided a useful framework for categorising the types of value differences perceived. Mathematical values relate to the mathematics discipline itself, and they have been identified to be the three complementary pairs of *rationalism* and *objectism, control* and *progress,* and *mystery* and *openness* (Bishop, 1988). On the other hand, mathematics educational values refer to the objects, experiences, and pedagogies that students and teachers consider important to learning and teaching mathematics (Seah, 2019). Last but not least, general educational values cover the moral, ethical, citizenship, and sometimes, religious values that a given educational system aims to impart to its students. Unlike the first two categories of values, general educational values are part of the educational process but are not directly related to mathematics instruction.

METHODS

Data were collected online using the 'What I Find Important Too' questionnaire, accessible at https://www.surveymonkey.com/r/VASstu_v4. The questionnaire draws on hypothetical situations to encourage student respondents to delineate instances where disparities exist between their own values and those emphasised by their teachers during mathematics lessons (E, 2023). Here we focus on the open-ended question posed: What was the value differences situation like?

Participants were chosen via stratified probability sampling of schools across Victoria, ensuring diversity in terms of gender, ethnicity, and educational background. The 625 participants (50% female) were from urban and regional secondary schools located in Victoria. Students self-identified their ethnicities as Australian (349), European (116), Asian (73), North African and Middle Eastern (17), Americans (9), Indigenous Australian (6), Sub-Saharan African (4), and Other (43).

Students' responses were analysed using thematic analysis (Braun & Clarke, 2006). Initial nodes were generated and coded inductively. For example, "I asked her to teach in a way that we could all understand" was coded as *understanding* to reflect this valuing. Subsequently, nodes were organised deductively into value categories, guided by a checklist that included three pairs of mathematical values (Bishop, 1988) and seven pairs of complementary mathematics education values (Kinone et al., 2020). For example, the value nodes *understanding* and *textbook* were categorised as 'mathematics educational values'. The checklist provided flexibility, allowing for the identification of additional value categories.

RESULTS

29 instances of value differences were reported. While 10 (34.48%) of these were either maths educational or general educational values, a majority could not be located within the three value categories which Bishop (1996) identified. Rather, they appeared to relate to mathematical content. Bishop's (1996) three-category system does not seem to adequately describe the range of value differences perceived by secondary school mathematics learners. As a result, an additional category – mathematical content values – is being proposed here.

Mathematical content value differences refer to those incidents when specific mathematical content that is important to the teacher is not important to the students, and vice versa. Of the 29 value differences reported, 19 of these were related to student and teacher differences in valuing particular mathematical content. Specifically, within this category, 11 students referenced they did not find algebra to be important. For instance, one student noted, "It [algebra] is just numbers and letters mixed up together; it is not reality". Five students did not specify the name of content, but they also expressed disagreement with their teachers' view that some specific mathematics knowledge was important, noting for instance, "we were learning something in maths that we are never going to use in everyday life and my teacher said it was important". The rest of the mathematical content value differences pertained to numerals, coordinates, addition/subtraction, geometry, trigonometry, equations, data and stats.

Our data suggested that these mathematical content value differences often stemmed from students' questions about the usefulness of the specific content. The thought process of students revealed that while they would try to assess the value of these mathematical concepts based on their perceived usefulness, this approach often fails to convince them. For example, one student remarked, "we will never use it [algebra] in the future because why would people make people waste their time when there [sic] shopping and try and figure out what the hidden number or something." Another student questioned the importance of trigonometry, stating, "but teacher thinks it is important. How will we use [this] mathematics in day-to-day scenarios?" Interestingly, teachers' justifications for the mathematical content value, as mentioned in students' responses, also emphasised its usefulness in careers, everyday life, and future. One student emphasised, "we were learning something in maths that we are never going to use in everyday life and my teacher said it was important, but I didn't take it seriously because it was useless. She [my teacher] gave me a situation of how we would use this maths content in everyday life, and it was something that would never happen". In this instance, the concerned teacher attempted to address the disparity in values related to mathematical content by highlighting its practical relevance in everyday life, but she was not successful in engaging their students in her endorsement.

Mathematics educational value differences were next most commonly reported by the secondary school participants, where the source of difference rooted in the differing perceptions of teachers and students regarding approaches to mathematics teaching and learning respectively. There were nine of the 29 value differences documented which pertained to the nature of mathematics educational values. Specifically, there were 5 instances which revealed differences in valuing between teachers' teaching relying on textbook questions and students' embracing of other pedagogies. For example, a student pointed out, "My teacher doesn't listen to us and she thinks by doing textbook questions it'll help us, which isn't true". From what a student wrote, "I think that doing the same type of questions all the time is unimportant. My teachers make us repeat them all the time", it appears that students interpreted their teachers' value as repetition unnecessarily. Indeed, other students wrote their maths education values that "I want constant and different types of problems", "I asked her to teach in a way we could all understand and not just do workbook everyday", "I have difficulties taking in information because as a class we just do book work and other teachers use different methods to teach their classes … I told her [my teacher] to use different examples and/or teachings skills" and "It becomes boring to do that many questions, which means we don't concentrate well in class". Notably, these responses reflected Kalogeropoulos's (2016) assertion that students who hold different values from their teachers are likely to resist or disengage from pedagogical activities, negatively impacting their interest and performance in mathematics.

Only one student referred to value differences of the general educational value nature. It involved the differing valuing of *equity*: "We had a deadline and most of us met it, but some didn't, so the deadline was extended. I thought that was unfair to the people who had worked hard to meet the deadline". Perhaps one possible explanation is that generally these values are already accepted by the (educational) community, such that the chance of any such value being involved in value difference situations was less likely. In fact, Seah (2019) suggested that general educational values are already being inculcated in students as part of fulfilling the professional and ethical responsibilities of teaching.

DISCUSSION AND CONCLUSION

Although our data about mathematical content value difference situations suggested that some teachers emphasise the importance of mathematical content due to its usefulness, it cannot be definitively categorised as valuing *application*. *Application* as a mathematics educational value refers to "valuing application of mathematics in various problematic situations in mathematics learning" (Kinone et al., 2020, p. 44), which is more aligned with emphasising pedagogies that can enhance students' abilities to recall factual knowledge and concepts readily and flexibly to find solutions for mathematical questions. However, teachers highlighted the importance of mathematical content in everyday life and future jobs/careers. This emphasis seems to extend beyond mathematical learning and appears unrelated to pedagogy, making it incompatible with the mathematics educational value as defined by Bishop (1996).

In addition to defying categorisation within existing value categories, there are also arguments for acknowledging the mathematical content value category. Current knowledge about values (Seah, 2005) suggested that cultures construct and develop mathematics in different ways, resulting in educational systems that reflect what cultures consider valuable, that is, what they value. In other words, mathematics is socialised knowledge; knowledge that has been cultivated and developed in response to particular needs within cultures, not objective knowledge (Clarkson et al., 2019). This implied that mathematical knowledge is selected and organised to become content knowledge for teaching and learning, a process inherently embedded with values. Illustrating this is the stated aims for revising the Australian mathematics curriculum (ACARA, 2021), which highlighted the need to "remove outdated and non-essential content, add new content that has been identified as important for students to learn, better sequence student learning and give teachers greater clarity and guidance about what they are expected to teach" (p. 1). Although this document does not explicitly state why certain contents are considered important for teaching and learning, what it does highlight is the value attributed to different mathematical content.

This study has emphasised the need to focus on mathematical content values. It is noteworthy to reflect on the fact that prior studies have often approached the body of mathematical knowledge as a whole, emphasising its importance as long as the existence of specific content that can be applied in everyday life or future careers can be justified. However, clear indications suggest that students may encounter difficulties in discerning the value of each piece of mathematical content. This aligns with Atweh et al.'s (2010) observation that students persist in believing that some content is largely meaningless, particularly when teachers cannot demonstrate how all mathematical concepts can be applied to real-life situations. Recently, Rosenzweig et al. (2020) emphasised that a more effective way to increase student utility is to help students think about the value of course material, which seems to suggest a new trend: a return from considering body of knowledge as a fixed whole to a focus on specific content knowledge. Therefore, the urgent next step is to concentrate on mathematical content values and find a way to respond to situations in which students do not see the value of learning particular mathematical content.

In most value difference situations involving mathematics educational values, teachers tend to value practicing problems in textbooks, but students generally do not value this way of learning mathematics. Notably, our findings demonstrate how problematic it can be with teachers' heavy dependence on the mathematics textbooks, as students appeared to associate textbook use with mechanical or habitual repetition. This result may not be surprising given that secondary-level mathematical textbooks are often filled with relatively low-level, repetitious exercises (Stephens, 2019). Rather than repeatedly solving the same types of problems found in the textbooks, students are more likely to seek diverse examples and instructional methods that are aligned with their mathematics educational values. What this implies is that educators and teachers who rely on textbooks need to consider how to meet their students' mathematics educational values by carefully selecting or redesigning textbook problems (e.g., by changing just one or two numbers to extend learning opportunities). Otherwise, these students with conflict values from their teachers would exhibit resistance or disinterest in pedagogical activities.

Inherently, repetitive and low-complexity problems are not necessarily bad, because students learn procedures through sufficient repetition. However, this pedagogy relying on overwhelming prevalence seems to limit students' opportunities to feel and contemplate the value of mathematical content. An example can be found in early research; Goldin (2004) expressed concern over the inclusion of activities related to solving discrete mathematics problems in the secondary school mathematics curriculum. In his words, if these problems were added to standardized achievement tests with the intention of evaluating nonroutine problem-solving skills, then routine methods for solving them would be explained and utilised in numerous parallel practice problems in school workbooks. This means that this particular knowledge is included in the mathematics curriculum as a set of information to be memorised and strategies to be used routinely, which is exactly the aspect that is not valued by students frequently mentioned in mathematics educational value differences situations. More importantly, in this way, the potential of discrete mathematics in terms of triggering attributes such as experimentation, logical reasoning, and problem-solving would certainly be diminished (Goldin, 2004). This seems to reveal the mathematical content value of learning discrete mathematics, but it is obscured by certain pedagogy. It is also worth reflecting on the fact that these attributes have been described in previous studies as characteristics of the mathematical discipline as a whole, rather than analysing the relationship of the individual essential mathematical content to these attributes. The question raised here is whether specific mathematical contents containing these attributes are the precise reason the discipline of mathematics exhibits these characteristics at the macro level. Therefore, it is necessary to unpack the values embedded in each mathematical content.

To conclude, the present study investigated Australian secondary school students' experiences of perceived value differences in mathematics lessons, and identified 29 perceived value differences in the data collected, which revealed the need to add a new category, namely, mathematical content value, to the existing classification. The mathematical content category was reported most frequently in this research study, further indicating an issue: students do not value particular mathematical content. Conversely, the mathematics educational values perceived by secondary students nearly all relate to their teachers' values related to teaching from textbooks. Students in Australia often face struggles when their teachers rely solely on mathematics textbooks for teaching. This is due to the textbooks being filled with repetitive and straightforward problems, which is in conflict with students' mathematics educational values. Thus, the findings of this study could offer teachers inspiration to enhance their pedagogy, aligning it with students' values in mathematics education.

References

Atweh, B., Clarkson, P., & Seah, W. T. (2010). What values do middle school students attribute to studying mathematics: A pilot study. In W. Chang, D. Fisher, C. Lin & R. Koul (Eds.), *Envisioning the future* (pp. 9–20). Curtin University.

Australian Curriculum, Assessment and Reporting Authority. (2021). *What has changed and why? Proposed revisions to the F–10 Australian curriculum: Mathematics.* https://www.australiancurriculum.edu.au/media/7120/ac_review_2021_mathematics_whats_changed_and_why.pdf

Bishop, A. J. (1988). *Mathematical enculturation: A cultural perspective on mathematics education*. Kluwer Academic Publishers. https://doi.org/10.1007/BF00751231

Bishop, A. J. (1996). *How should mathematics teaching in modern societies relate to cultural values—Some preliminary questions.* Paper presented at the Seventh Southeast Asian Conference on Mathematics Education.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Clarkson, P., Seah, W. T., & Pang, J. (Eds.). (2019). *Values and valuing in mathematics education: Scanning and Scoping the Territory*. Springer International Publishing. https://doi.org/10.1007/978-3-030-16892-6

E, A. (2023). *Value alignment strategies in Australian mathematics classrooms* [MEd thesis]. The University of Melbourne.

Goldin, G. A. (2004). Problem solving heuristics, affect, and discrete mathematics. *ZDM*, *36*(2), 56–60. https://doi.org/10.1007/BF02655759

Kalogeropoulos, P. (2016). *The role of value alignment in engagement and (dis)engagement in mathematics learning* [Doctoral thesis]. Monash University.

Kalogeropoulos, P., Russo, J. A., & Clarkson, P. (2021). Exploring educator values alignment strategies in an intervention context: The emergence of the beacon strategy. *ECNU Review of Education, 4*(2), 327–348. https://doi.org/10.1177/2096531120923127

Kinone, C., Soeda, Y., & Watanabe, K. (2020). The influences of teacher valuing on the development of student valuing in mathematics education [in Japanese]. *Journal of Japan Academic Society of Mathematical Education, 26*(1), 43–58. https://doi.org/10.32296/jjsme.95.rs_105

Rosenzweig, E. Q., Wigfield, A., & Hulleman, C. S. (2020). More useful or not so bad? Examining the effects of utility value and cost reduction interventions in college physics. *Journal of Educational Psychology*, *112*(1), 166–182. https://doi.org/10.1037/edu0000370

Seah, W. T. (2005). *The negotiation of perceived value differences by immigrant teachers of mathematics in Australia*. [Doctoral thesis]. Monash University. https://doi.org/10.4425/03/59c9f2bfd2481.

Seah, W. T. (2019). Values in mathematics education: Its conative nature, and how it can be developed. *Research in Mathematics Education, 22*(2), 99–121. https://doi.org/10.7468/jksmed.2019.22.2.9

Seah, W. T., & Andersson, A. (2015). Valuing diversity in mathematics pedagogy through the volitional nature and alignment of values. In A. Bishop, H. Tan, & T. N. Barkatsas (Eds.), *Diversity in mathematics education: Towards inclusive practices* (pp. 167–183). Springer International Publishing. https://doi.org/10.1007/978-3-319-05978-5_10

Stephens, M. (2019). Embedding algorithmic thinking more clearly in the mathematics curriculum. In Y. Shimizu, R. Withal (Eds.), *Proceedings of ICME 24 School mathematics curriculum reforms: challenges, changes and opportunities* (pp. 483–490). University of Tsukuba.