



Teaching and Learning Mathematics in a Period of Changes: What Remains Unchanged

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ABSTRACT

Without a doubt, the next quarters of the 21st Century will be characterized by accelerated change across all aspects of human life, thanks mainly to breakthroughs in digital technologies. The teaching and learning of mathematics in schools are accordingly affected, for better or worse. Both teachers and students need to be able to navigate these changes - and the uncertainties that accompany them - in ways that optimize the teaching and learning of the discipline, respectively, while maintaining the well-being of mathematics education for all involved. An argument will be made in this paper that what is needed more than ever to facilitate this navigation is something which remains unchanged in a context of continual change, that is, the culturally based values related to mathematics and to its pedagogy. Examples of these include rationalism, fluency, and practice. How values underlie aspects of mathematics education that have become significant in recent years, namely, values alignment, mathematical wellbeing, and mathematics competencies, will be discussed. Understanding the central roles of values in these and other aspects of mathematics education in the 21st Century would thus empower teachers to better interact with students, foster and maintain their mathematical wellbeing, and develop in them relevant mathematics competencies for empowered living in the period of change.

INTRODUCTION

As we embark on the second quarter of the 21st Century, the world faces several global issues with enduring impact. Some of these (e.g., climate change) might have been around for quite a while, but each presents challenges for mathematics education in contemporary classrooms.

Greying populations (especially in the developed world) have led to extensions of (teacher) retirement ages, increasing the opportunities for values misalignment between teachers and students, in turn affecting pedagogical effectiveness (Kalogeropoulos et al., 2021). At the same time, accelerating advances in digital technologies have enabled increasingly more tasks to be accomplished with great efficiency, prompting even more instances of the age-old question being posed by students: “When will I ever use this (mathematics) in the future?”

WHAT REMAINS UNCHANGED

In this context of changes and disruptions around the world, and thus also in school classrooms, what seems to have remained unchanged over the years are the values that communities and individuals embrace in relation to mathematics and mathematics education. This kind of value refers to the attributes of the discipline and its pedagogy that are significant to communities and individuals. More formally, “valuing is defined as an individual’s embracing of convictions in mathematics pedagogy which are of importance and worth personally. It shapes the individual’s

willpower to embody the convictions in the choice of actions, contributing to the individual's thriveability in ethical mathematics pedagogy" (Seah, 2019, p. 107). Thus, for instance, a community or mathematics education system might value *rationalism* (Bishop, 1988), a value that very much characterizes the discipline of mathematics. A student might value *practice* in mathematics learning, which serves their higher-order valuing of, say, *achievement* or *accomplishment*.

By their nature, values are internalized and tend to be rather stable within communities and individuals who embrace them. In addition, the conviction and passion with which values (in mathematics education) are embraced have led to such phenomena as the 'math wars' in the United States in the 1990s, as well as the current debates in Australia and New Zealand over the governments' valuing of *explicit teaching* (as opposed to *inquiry-based approaches* which had been valued in that region in the last two decades or so). At the individual level, migrant teachers of mathematics in Australian schools might be surprised to find themselves not as prepared to teach mathematics after arriving in Australia: whilst the school mathematics they were expected to teach in the Australian classroom might be similar to that in their respective home cultures, the ways it is taught and learnt in the different mathematics education systems would have been guided by cultural values that could be very different (Seah, 2004). An example would be the differential valuation of *textbooks* across different mathematics education systems. Teachers who are used to teaching mathematics with whole-class textbook use may find it professionally challenging when schools in their host cultures do not use textbooks.

VALUES IN CLASSROOM INTERACTIONS

That values remain an invariant aspect of mathematics education across cultures is important because it allows us to better understand how mathematics education has evolved over time. When this understanding is applied to the current period of change as we enter the second quarter of the 21st Century, we can more effectively and meaningfully respond to developments in mathematics education triggered by phenomena such as climate change, greying populations / low birth rates, and advances in digital technologies.

For example, the role of values in shaping the professional socialization experience of migrant mathematics teachers in Australia has a more general parallel in every mathematics classroom: the unavoidable values misalignment between teachers and students, and amongst students. In any (mathematics) classroom anywhere, there is bound to be differences in what the teacher and their students value in relation to mathematics and to mathematics pedagogy. A teacher may value *process*, encouraging their students to explore alternative solutions to a particular problem. On the other hand, their students might generally value *product*, looking only for and consistently using the most efficient solution. Indeed, the effectiveness of any mathematics lesson might really be a function of the extent to which the mathematics teacher is able to negotiate the value differences and conflicts that inevitably present themselves.

Kalogeropoulos et al. (2021) reported on a series of strategies used by teachers to negotiate these value differences/conflicts in the mathematics classroom, promoting value alignment in mathematics lessons. These strategies reflect how much of the teacher's and students' values are preserved in achieving value alignment across different contexts. Based on a study with teachers in Australian schools, these strategies were presented along a continuum. They are, namely, beacon, scaffolding, balancing, intervention, and refuge, in decreasing degrees of teacher values being dominant over the students'. These strategies are used in different combinations in a single lesson, since teachers make decisions in each value difference/conflict situation according to their assessments of the relative importance of their values in each instance, while also being inclusive and responsive to students' valuing (Kalogeropoulos & Russo, 2025).

VALUES IN MATHEMATICAL WELLBEING

Values (and valuing) have also been a central component in fostering mathematical wellbeing (MWB) amongst learners. It was first conceptualized by Clarkson et al. (2010), who presented it as a five-stage developmental model. These stages bring together the cognitive and affective aspects of mathematics education, beginning with awareness and acceptance of the mathematical activity, progressing to a positive response, then to valuing, to systematic valuing, and finally to MWB being reflected in a learner having the competence and confidence to engage with the mathematical activity.

The more recent conceptualization of MWB refers to the subjective state in which a mathematics learner feels good and functions well (Hill et al., 2021). It appears to be guided by Tiberius' (2018) value fulfillment theory. This theory holds that the development of well-being reflects the extent to which values are fulfilled. That is, the more personally held values are fulfilled, the greater the sense of well-being associated with these values. A set of seven values was identified through a scoping review of relevant prior studies, and subsequently validated by students in Australia and New Zealand. Thus, from this perspective, providing students with opportunities to optimally fulfill their valuing of *accomplishment, cognitions, engagement, meaning, perseverance, positive emotions, and relationships* would promote MWB, positioning students well to learn mathematical knowledge and skills.

VALUES AS COMPETENCIES

Beyond the individual, the values that are embraced by institutions and the wider society also affect the teaching and learning of mathematics. One manifestation of values is the competencies that education systems seek to develop in students.

Both mathematical competencies and their pedagogy, however, are not new phenomena. At the turn of this century, the National Research Council (NRC) (2001) in the United States had “chosen *mathematical proficiency* to capture what we believe is necessary for anyone to learn mathematics successfully That proficiency should enable them to cope with the mathematical challenges of daily life and enable them to continue their study of mathematics in high school and beyond” (p. 116). Mathematical proficiency is considered here to encompass five interwoven and interdependent strands: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition (NRC, 2001).

Over the last two decades, however, the purpose of acquiring competencies seems to have shifted from facilitating mathematics learning (NRC, 2001) to developing the “ability to meet complex demands, by drawing on and mobilizing psychosocial resources (including skills and attitudes) in a particular context” (OECD, 2005, p.4). This is reflected in the Australian Curriculum, for example, in which the four identified “proficiencies enable students to respond to familiar and unfamiliar situations by employing mathematical strategies to make informed decisions and solve problems efficiently” (ACARA, 2009). This, despite the observation that the four proficiencies - understanding, fluency, problem-solving, reasoning - are similar to four of the five American ones which we saw above.

The age-old question of “When will I ever use this (mathematics) in the future?” was mentioned at the beginning of this paper. The best answer to this question might well be that mathematics is not being learned for the sake of acquiring concepts and skills, given that artificial intelligence applications can solve mathematical questions quickly and often accurately. Rather, we aim to develop competencies through the mathematics learning process, as noted in documents such as the OECD (2005) document mentioned above.

FEATURES OF MATHEMATICS EDUCATION ARE VALUES TOO

The last three sections have attempted to show how values underlie three contemporary features of mathematics education, namely, values alignment, mathematical wellbeing, and mathematics competencies. In many mathematics education systems, these three features are rather new considerations, reflecting current evolutions in the world as we enter the second quarter of the 21st Century. Teachers in classrooms around the world might have been engaging with values alignment as part of effective classroom management practices, but its significance (including the roles that values play) seems to have been more explicitly recognized only at the beginning of this century, with the research of Kalogeropoulos (2016). MWB might have been conceptualized in the 2010s, but it was the COVID-19 pandemic that sparked interest and concern about students' well-being, as schools shut down and learning pivoted to online teaching worldwide. As for mathematics competencies, even though they might have been perceived, in some cultures, as the objective of learning school mathematics all along, they have only found their way into mathematics education policies and curricula in the last 20 years or so.

In fact, values alignment, mathematical well-being, and mathematics competencies are all examples of values. They are all attributes of mathematics education that are currently being widely embraced, perhaps globally. As we saw above, these values have been embraced by some mathematics education systems long before they became prominent, and we can expect them to continue valuing them in their respective education systems. As for the other education systems, which may be new to any of these three features, the extent to which they value conflicting

attributes in the context of the current world order would very much determine how they adopt mathematics competencies, values alignment, or mathematical wellbeing. This might also stimulate changes in priorities in the next few years.

VALUES BEING CULTURALLY-SITUATED

While priorities - and thus, features - of mathematics education might change as economies and societies evolve, the values underlying these are probably much more stable. As might have been seen from the examples shown earlier in this paper, these values are culturally based and have proven useful for the needs of the communities in which they function. For example, current understanding of values alignment reflects the classroom (mathematics) teacher exercising flexibility over the extent to which their own values are held onto relative to their students'. This approach to values alignment might reflect lower power distance (Hofstede et al., 2010), which typically exists in Western cultures. We can never be certain whether the same applies in other cultures, where a higher power distance is associated with a different set of values regarding mathematics pedagogy.

Similarly, the prevailing MWB model developed by Hill et al. (2021) might have been informed by a scoping study and supported by empirical data collected in Australia and New Zealand, yet the reality is that the literature interrogated in the scoping study was written and published in English. Relevant disciplines and pedagogical values reflecting the wealth of knowledge in mathematics education research in non-English-speaking cultures remain unknown in Western societies. Nor is there much need or motivation for these to be known in Western societies, though a point may still be made about the increasingly multicultural nature of mathematics classrooms in these societies.

Indeed, a longitudinal study (Zhong & Seah, 2024), which has been conducted in Chengdu, China, since 2021 with students (who were studying in Grade 3 at that time), has not identified *cognitions* as a value that needs to be fulfilled to support students' wellbeing, contrary to Hill et al. (2021). Instead, the Chinese mathematics lessons appeared to value *competencies*, which, through my interactions with educators in China since the 1990s, have often been highlighted as a key value of mathematics education.

In fact, data collected from elementary students in China (Zhong & Seah, 2024) and secondary students in Indonesia (Wijaya et al., 2026) suggest that the values that underlie students' mathematics education well-being in these Asian countries were the ones that reflect the human needs identified in Ryan and Deci's (2000) Self-Determination Theory, namely, *autonomy*, *competence*, and *relatedness*. While *autonomy* may not be one of the values in the Hill et al. (2021) MWB model, *relatedness* might be similar to *relationships* that were found to be crucial in fostering MWB amongst Australian and New Zealand students.

IMPLICATIONS FOR CLASSROOM PRACTICE

Since culturally relevant values continue to underlie mathematics teachers' classroom practice despite the world becoming increasingly multicultural, teacher awareness and understanding of these values, as well as how to effectively foster them amongst students, are important professional skills. Subjects in pre-service teacher education courses that are associated with local history or the sociology of education would be an excellent stimulus for understanding the values. Lesson designs that reflect the valuing of relevant attributes should be shared amongst teachers, with the values explicitly stated. Equally importantly, the current emphasis on competency-based approaches to mathematics education in many education systems should be regarded as fostering amongst students values of enabling and empowerment resulting from mastery of mathematical knowledge and skills.

CONCLUDING

Acknowledging that values underlie contemporary features of mathematics education is important. While values alignment, MWB, and competency-based mathematics pedagogy might represent some of the many changes in mathematics education in this new era of digital technologies, the values driving these changes are relatively stable and internalized, at the same time reflecting what has been and remains important to the societies within which the mathematics lessons take place. That the world has become multipolar has also raised global awareness of the roles of non-Western values in all aspects of life, and mathematics education is not immune to such development. Knowing what these underlying values are and understanding how they underlie changes in mathematics education, we can

more intentionally guide our students to further internalize and practice relevant values through their mathematics learning, so that they can better navigate the changes, uncertainties, and challenges of the next quarters of the century.

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