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MATHEMATICS TEACHER EDUCATION SHOULD BE RESPONSIVE TO A RAPIDLY CHANGING WORLD

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INTRODUCTION (OLIVE CHAPMAN)

The theme of the PME-45 conference, *Mathematics education research supporting practice: Empowering the future,* not only highlights the importance of research to improving the quality of mathematics teaching and learning but also the importance of teacher education to empower teachers to impact practice in a timely, relevant, and meaningful way. Hence, this plenary panel considers the latter by debating the motion: *Mathematics teacher education should be responsive to a rapidly changing world.*

Rationale

In response to perceived needs of the 21st-century, knowledge-based, digital society, global education policies, research, and professional organizations advocated reforms to mathematics education that included teaching to support conceptual understanding of mathematics and mathematical thinking. Such reforms could be linked to the focus on developing teachers' *mathematics knowledge for teaching,* needed to support deep mathematical understanding, with an orientation towards content knowledge and pedagogical content knowledge. However, the 21st century has presented us with a rapidly changing world with implications for mathematics education and consequently mathematics teacher education (MTE) that are more complex and challenging than initially perceived; implications that could require (re)consideration and new/renewed understanding of the nature of the mathematics classroom, the mathematics teacher, and MTE to enable them to live well in this changed and changing world. Thus, focusing on MTE (including preservice and inservice teachers), this plenary panel aims to draw attention to, and provoke discussion of, what the rapidly changing world means to MTE and whether MTE should be responsive to the rapid changes.

Teacher education in a changing world

Darling-Hammond and Bransford's (2007) edited book, *Preparing teachers for a changing world,* recommends that all new teachers must have strong disciplinary knowledge and basic understanding of how people learn and develop. It suggests that teachers must be able to apply that knowledge in developing curriculum that attends to students' needs, the demands of the content, and the social purposes of education that include teaching content to diverse students, managing the classroom, assessing student performance, and using technology in the classroom. These suggestions of

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factors to be considered in preparing teachers for a changing world seems to align with those that have been addressed in MTE based on research in the field. But they do not fully or appropriately represent concerns of the rapidly changing world we have been experiencing and will continue to live in with seemingly unpredictable effects of some changes. However, recent publications on the changing context of mathematics education and implications for MTE have further addressed technology and equity.

Most recent publications on mathematics education have focused on the changing world in terms of the *digital age* and *equity*. Regarding the digital age, Clark-Wilson et al.'s (2021) edited book, *Mathematics education in the digital age*, addresses the impacts the digital age has, and will continue to have, on the learning and teaching of mathematics within formal education systems/settings. It suggests that it is important for the design and evaluation of MTE and professional development programs to embed the knowledge, skills, and attributes to teach mathematics with digital resources. Niess et al. (2016) also focused on the digital age in the *Handbook of research on transforming mathematics teacher education in the digital age*. The book addresses the development of teachers' knowledge for the integration of technologies to improve classroom instruction. Based on research on emerging pedagogies for preservice and inservice teachers, it suggests how mathematics teacher educators must and can think beyond their own backgrounds to incorporate current and emerging technologies into their efforts to prepare students to teach mathematics.

Regarding equity, Xenofontos's (2019) edited book, *Equity in* m*athematics education: Addressing a changing world*, reconsiders the concept and/or practice of equity, and its related concept, social justice, and the role of mathematics education research in addressing and promoting a fairer world. It offers "practical suggestions" on how equitable teaching practice could be included in MTE and suggestions for inservice teachers to implement in their classrooms. Other publications have focused on the impact of the Covid-19 pandemic on mathematics education with consideration of both technology and equity; for example, the Educational Studies in Mathematics special issues on *Mathematics education in a time of crisis—a viral pandemic* (vol. 108, issues 1-2, 2021). Some studies have taken a sociopolitical turn that "seek not just to better understand mathematics education in all of its social forms but to transform mathematics education in ways that privilege more socially just practices" (Gutiérrez, 2013, p. 40), with different implications for MTE.

While this emerging body of literature addresses issues related to mathematics education in a changing world with MTE being a way to react to proposed changes in the classroom, the plenary panel intends to put MTE at the forefront regarding its role to being proactive and responsive to a rapidly changing world. This positioning of MTE links it to factors, such as technological, socioculural, sociopolitical, geopolitical, biopolitical; and socioeconomical global situations that underlie our rapidly changing world. Specific situations include artificial intelligence; epidemics; mental health; environmental/climate change; war; displaced populations (migratory crisis); diversity,

equity, and inclusion; and decolonization. There is no question that such situations have implications for mathematics education based on the global needs of the students in our classrooms. The effects of these situations are present in the learners who arrive in our mathematics classrooms every day. Thus, it is important for teachers and teacher educators to become knowledgeable of the interplay between school mathematics and mathematics education and the issues arising from these situations that impact students and their communities. This is necessary for mathematics education to realize its full potential for the 21st century. However, achieving this potential is likely to be challenging for the field of mathematics education given the significant shifts in conceptualizing mathematics and the learning and teaching of mathematics that will be needed to address the changing world, the lack of a global theory/perspective of mathematics pedagogy, and educational policies outside of the control of the field. These challenges are also applicable for MTE.

For MTE to realize its full potential to support initial teacher education and teacher professional development, it should be responsive to the changing world. But to what extent is this achievable or even possible? MTE was adapted or changed to address the requirements of the reform movement in mathematics education, but after about three decades we are still far from achieving reform on a significant level across the globe. So, would MTE be more successful in being responsive to a rapidly changing world?

One concern for MTE is teacher knowledge. Research on *mathematics teacher knowledge for teaching* suggests different but related models of what this knowledge should be. Would some models be more appropriate now or would new models need to be developed? Would focusing on identity and power (Gutiérrez, 2013), for example, be of more importance than current models without this focus? As Gutiérrez states,

> we are also at a time when not attending to identity and power means we are at best fooling ourselves about future prospects and at worst likely to ensure that mathematics education will be unable to realize its full potential for the 21st century. (p. 38)

Then, what would such a shift in teacher knowledge or characteristics mean for mathematics teacher educators' knowledge? Mathematics teacher educators' knowledge for teaching teachers is not well established since research on mathematics teacher educator knowledge is fairly new. In order to be responsive to a rapidly changing world, what knowledge will teacher educators need? This knowledge will depend on what ought to be the purpose of MTE in a rapidly changing world. In addition to teacher educators' knowledge and ability to respond to all types of change, there are several issues/questions that must to be addressed to understand the practicality of MTE being responsive to changes in the world. For example, there are issues associated with: autonomy to decide on what changes are relevant; cost of implementing change; teachers of different education levels and contexts; diversity in meaning of being responsive; and diversity in mathematics pedagogy and teacher education around the world. The plenary panel addresses these and other issues.

Structure of plenary panel and presentation

The presentation adopts the Oxford debate structure consisting of a panel of debaters and a moderator. Based on this structure, the 90-minute live session, moderated by Olive Chapman, includes opening remarks by each panelist, followed by an intra-panel discussion, then a question-and-answer period involving the audience, and finally brief closing remarks by each panelist. The panel consists of two teams of two members on opposite sides of the motion being debated. Paola Sztajn and Nancy Chitera make the case ***for*** MTE being responsive to a rapidly changing world. Nuria Climent and Jaguthsing Dindyal make the case ***against*** MTE being responsive to a rapidly changing world. In the following sections of this paper, the panelists provide summaries of their main arguments to support or oppose the motion. Each section was written solely by the panelist, as indicated in the heading of the section, and thus, reflects the thinking of that panelist. We hope the preceding discussion in the introduction section and the ideas in sections that follow will inspire further discussion of the motion.

"WE" IN MATHEMATICS TEACHER EDUCATION: BEING RESPONSIVE TO A RAPIDLY CHANGING WORLD (PAOLA SZTAJN)

"I can't do that at my school. That is not what my principal wants." "I am seeing practices in the classroom that I can't reconcile with what I am learning in my teacher education courses." "My mentor teacher told me to teach more like them. So I did, because it works in the classroom."

As a scholar and practitioner in MTE, I have heard statements such as the ones above too many times. They stem from a tension that continues to exist between what is taught in post-secondary mathematics teacher preparation programs and what is experienced in P-12 school mathematics teaching. This tension positions the two groups as "us" versus "them". It is my position that until mathematics teacher preparation and mathematics classroom teaching partner in ways that honor both practices and their different knowledge, we will continue to experience this tension in the education of mathematics teachers. Because I consider such tension unproductive, it is important to bridge the divide between MTE and mathematics classroom teaching to create a space in which the preparation of mathematics teachers is examined as the work "we" (classroom teachers and teacher educators) do. I contend that making MTE more responsive to a rapidly changing world, in ways that are more similar to what teachers are often asked to do, is one step toward bridging the divide.

Mathematics teacher education as boundary encounters

In Sztajn et al. (2014), we proposed that the work of MTE happens at the boundary that separates and connects different communities. At that time, we were interested in the question of how research-based and practice-based knowledge interact in MTE. We suggested it was myopic to place the knowledge needed to improve teaching (and I add, to improve MTE) either within the research domain or classroom-practice domain. Instead, we proposed that research and practice needed to come together as partners in

MTE, and we conceptualized the partnership that happens between researchers and practitioners within MTE as a boundary encounter (Wenger, 1998).

We noted two important premises for the partnership between research and practice. First, the research community has knowledge about students' mathematics and mathematics learning that has the potential to be useful to teaching. Second, the teaching community has knowledge about students' mathematics and mathematics learning in context that is of utmost importance for mathematics education researchers. From these premises, we suggested that bringing together those who work in the preparation of mathematics teachers and those who teach P-12 mathematics created opportunities for knowledge exchange among these communities—opportunities that I now claim are key to strengthening MTE. Further, we noted in the paper that it was the difficulty of creating and exchanging knowledge at the boundary that made those encounters transformative.

I believe the transformative processes happening at the border can unify different stakeholders working in MTE and create a space in which those working in post-secondary mathematics teacher preparation and in P-12 school mathematics teaching come together to design MTE programs that are shared in true partnership across the two communities. It is this work in partnership, which is responsive in nature, that can avoid statements like the ones listed in the opening paragraph, creating a "we" in MTE.

Mathematics teacher education as responsive work

Brokers who participate in boundary encounters translate, coordinate, and create alignment across groups (Wenger, 1998). They facilitate transactions across communities and introduce practices of one group into the other. Because by their design and due to their direct interactions with communities, schools are often expected and asked to be responsive to a rapidly changing world. I suggest that brokers working in MTE can bring issues that require responsive approaches into the post-secondary preparation of mathematics teachers. In what follows, I suggest a few areas of change that are impacting P-12 mathematics teaching and for which post-secondary educators' responsiveness seems important. In particular, I focus on three areas that are pertinent in the U.S. context: new technologies, societal changes, and students' wellbeing.

New Technologies

Technologies for classroom use are changing quickly and impacting P-12 classrooms, particularly in more urban and suburban affluent schools. In the United States, for example, one-to-one computer initiatives were implemented in school districts before they became common in post-secondary education. Due to the presence of vendors from various companies who are trying to sell "solutions" to school districts, it is not unusual for teachers to be piloting new technologies before they are considered in teacher education. The presence of tools that use artificial intelligence and approaches that collect and display data for teachers and other school leaders are also growing in schools, probably before they grow in many teacher education programs.

In such context, what is the role of those working in post-secondary mathematics teacher training? Whereas one can argue that higher education mathematics teacher educators can support analyses of the pros and cons of different technologies in light of different learning goals and theories, I would argue that a more responsive approach would include active participation in discussions and implementations related to new technologies, particularly in the decision-making processes in which school mathematics leaders are engaged when they have to make choices about product purchase. An interesting approach, for example, would be for innovative technologies to be tried simultaneously in the classroom and in teacher preparation. How would that transform practices at all levels of mathematics teaching? Spaces where all those involved in MTE are collaboratively looking at new existing technologies and websites for mathematics teaching and learning could promote the selection and use of resources that extend from teacher preparation to classroom practice.

Of course, there are also new technologies designed for teacher learning and not necessarily designed to promote learning of K-12 students. In these cases, responsive approaches to these technologies could also include partnership with P-12 teachers as they would be able to examine these technologies to consider their own learning. Thus, even in these cases, responsive approaches in which new technologies for mathematics teaching are examined as boundary objects within boundary encounters would be productive. These encounters would need to be ongoing and dynamic and operate at a pace that, sometimes, is faster than the usual pace in which higher education responds to technological changes.

Societal Changes

Changes in social contexts impact students at all levels. In P-12 schools, the more direct contact with families and communities can sometimes bring such changes faster into the classroom than in higher education. Again, as those working in mathematics teacher preparation and mathematics classroom teaching come together into boundary encounters, how can a shared examination of societal changes and emerging issues impact MTE, making it more responsive? In the case of societal changes, this responsiveness is key for engagement with learners.

In the United States, the past couple of years, beyond COVID, have been ones of social unrest. Different perspectives about the past, the ways in which different groups have been treated and the resulting existing inequalities have divided the nation creating a polarization that was not as evident in prior years. This divide has made the discussion of important issues and the education of all students (meaning really each and every student) more complex. This divisiveness impacts mathematics teaching and learning. Socially shared perceptions about who can and cannot learn mathematics, as well as discussions about the role of mathematics in helping students make sense of the (different) worlds in which they live matter.

Being responsive to societal changes and allowing discussions and issues that are part of students' lives into their mathematics education and the preparation of mathematics teachers is a key component for moving toward more equitable instruction. Because equity (or lack of thereof) continues to be a predominant educational problem in the United States, particularly in mathematics and other gate-keeping disciplines, MTE needs to respond to issues that are impacting the lives of learners. This response is not something that once done is complete; it needs to be systemic and systematic to matter.

Students' Wellbeing

Youth mental health has become a silent pandemic in our time. This is a national problem of such degree that the United States Surgeon General recognized the problem was widespread: students' feelings of helplessness, depression and suicidal thoughts are on the rise, and 20% of the young population is experiencing mental, emotional or behavioral disorders (Murthy, 2021). One more time, in this context, we see schools moving faster than higher education in recognizing and addressing the issues of student wellbeing, probably in part because there is a more consistent group of adults in K-12 schools that sees students on a regular, daily basis and can detect indicators of changes faster than more isolated adults in the teacher preparation context. But how will mathematics teacher educators take these new data and information about students' struggles with wellbeing into account? This is not an issue that can be ignored and on where, again, I argue mathematics teacher educators need to be responsive.

We in mathematics teacher education

Being responsive to the issues of our time, from my perspective, is not an option. Rather, it is part of the work we need to do in MTE, particularly if we conceive of such work as work that happens at the border between higher education and P-12 classrooms. I suggest this responsiveness can, in fact, be part of what brings MTE together as a single community that integrates those working in mathematics education in higher education institutions and those teaching mathematics in P-12 classrooms. Perhaps it is this coming together, around current issues in which both communities are responsive, that can bring groups together and improve MTE.

SHOULD MATHEMATICS TEACHER EDUCATION BE RESPONSIVE TO A RAPIDLY CHANGING WORLD? (NANCY CHITERA)

Does MTE get affected or influenced by global challenges? If so, are these influences across countries similar challenges in a rapidly changing world? How do countries respond to such influences? Are mathematics teacher educators taught on how to be responsive in the face of global challenges? This section of the paper discusses whether MTE should be responsive to global issues. The world is faced with many challenges that affect the education system. These global challenges include epidemics (e.g., Covid-19); climate change; displaced populations; and equity among others. Little work has been undertaken to understand the impact of global challenges on MTE and how responsive MTE has been. Most of the work published or documented focuses on

impact of these global challenges on the education system and how the education system responds. I argue that the global challenges have had a big impact on MTE and therefore raises the need for MTE globally to be responsive to our rapidly changing world despite the nature of existence of such challenges.

The context of Malawi teacher education

Malawi is a country in the southern part of Africa. English is its official language and Chichewa, which is spoken by about fifty per cent of the population (Baldauf & Kaplan, 2004), is its national language. The primary teacher education program runs for two years in teacher training colleges while secondary teacher education runs for four years. Both teacher education systems have two phases: the residential training when student teachers stay in college/university, attend lectures and complete projects and assignments, and the school-based education, which consists of teaching practice in various primary and secondary schools. Student teachers are expected to become conversant with content related to pedagogical knowledge such as the technical skills of lesson planning and teaching methods, as well as the specific learning areas that are offered in primary or secondary education, which includes numeracy and mathematics among others, consisting of subject content and methodology.

Purpose of mathematics teacher education

In teacher education institutions, the main objective is to help student teachers learn how to teach mathematics. In the face of global challenges, what would be the purpose of MTE and how would the teacher educators make their adjustments? Who will decide on what kind of adjustments are to be made and how should they change? For whose impact and for what purpose?

Teaching and learning mathematics, whether at primary, secondary, or tertiary level, aims at encouraging and enabling learners to appreciate and recognize that mathematics saturates the communities around us in addition of teaching them to become mathematicians. Learners will need to appreciate its worthiness and application in solving real-world problems. This is critical because mathematics provides learners with opportunities to develop their intellectual skills in solving real-world problems, development of deductive as well as inductive reasoning, coupled with creative thinking. Thus, MTE should aim at helping student teachers learn how to bring out the mentioned critical elements in an individual, which will involve consideration of the global challenges that the world is facing, such as COVID-19 and climate change.

The challenge that exists is that in most cases, preparing a teacher to teach mathematics has been taken for granted. So, does this mean that the purpose has to respond to global changes? Mathematics also helps us to understand the world and is a tool for developing our mental abilities. For example, logical and critical thinking, having creative ideas, abstract or spatial intelligence, development of problem-solving capabilities, as well as good business communication skills are all encouraged in mathematics. This shows that there is an implied great responsibility on MTE to model the teaching of mathematics accordingly. The assumption is that MTE should be modelled in such a

way that student teachers should be able to draw on even in the face of global challenges. This implies that the type of MTE discourse and how it is presented to the student teachers is very crucial. Student teachers learn and develop familiarity and confidence with such kind of discourse that is required in the face of global calamity.

Mathematics teacher education responsiveness to global challenges

Drawing on Wenger's (1998) notion of shared repertoire as the resources and tools used for knowledge (re)creation, it can be argued that for any development as a response to global challenges will need to be undertaken first to gain awareness of the complexity of MTE under such diverse global challenges. For example, what practices need to be addressed/challenged/included within the MTE to better prepare teachers to teach mathematics under the global challenges? There is also need to reflect on how classroom practices can contribute to the development of these transformative practices that will embrace new ways of thinking and acting in the face of a global challenge that are different than those that have guided MTE in the past. Guided MTE therefore calls for a proactive approach of doing things rather than being reactive, implying that MTE takes responsibility for the outcomes of its system, which will have to be accompanied by careful planning, being relevant and resourceful. This requires not only mathematics teachers, but all stakeholders charged with such responsibility at all levels.

Applying the notion of Community of Practice (CoP) developed by Wenger (1998) the implementation of the transformative response to global challenges as explained above requires to be seen within an emergent relationship between different stakeholders who can come together around a joint enterprise (a common area of interest), characterised by the existence of mutual engagement in the social practices such as the process of developing common understandings, routines, activities, stories, and ways of speaking and acting. Taking MTE as professional work, any transformative practices would require sharing experiences of norms and practices, together with sharing the ways of using certain tools. With the nature of global challenges and in the spirit of being pro-active, MTE needs to identify knowledge resources oriented to constructing responsive repertoires in the education system. This process includes how and what exactly should occur to implement meaningful responses to global challenges Figure 1 offers a model of changes that should be considered for MTE to be responsive to global challenges.

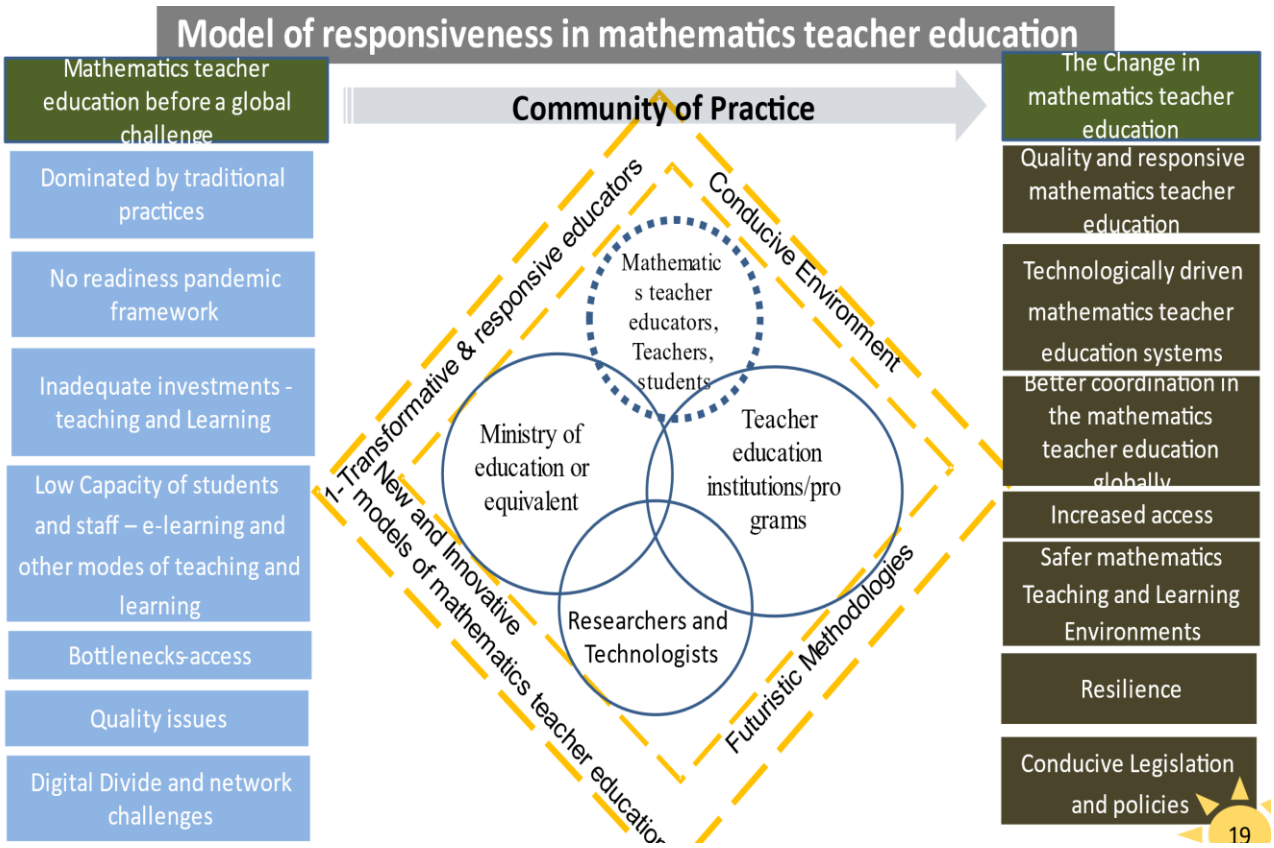

Figure 1: Model of responsiveness in MTE

MATHEMATICS TEACHER EDUCATION CANNOT BE CONSTANTLY RESPONDING TO A CHANGING WORLD (NURIA CLIMENT)

This section of the paper argues against the claim: *Mathematics teacher education should be responsive to a rapidly changing world*. The arguments are based on the notions of immediacy and "world" understood as a global homogenous world.

Immediacy versus responsibility

MTE cannot be drastically changing at every turn. Significant changes in MTE demand resources, political decisions, and social agreement. Moreover, a teacher education program needs coherence and a clear and solid orientation. All of these factors are incompatible with a continuous shifting from one position to another. This is not to say that MTE should not take into account socially and culturally important features and changes. While we cannot attend to the particularities of each new situation, we can attend to structuring elements within them. One of these is inequity. Many of the global and local crises are based on inequality and, as a result, inequality increases (Chan et al., 2021). Moreover, the capacity to react to rapid change is itself unevenly distributed (and heavily dependent on countries' richness, size, and cultural constrains, among others). As Chan et al. noted:

> In our research, we may find it important to study the local, immediate needs but also look

> at the big questions and examine the structure beneath the crisis. What is invariant? And where that structure is unjust, how can it be changed? (p. 6)

Working on inequality in MTE is to take responsibility for what happens from a deep and thoughtful response but not based on immediacy. Preparing teachers to be sensitive to inequality and difference will promote a kind of mathematics teaching oriented towards developing future citizens who are more respectful and sensitive to others.

From adapting teacher education to preparing flexible teachers

If MTE were orientated towards a flexible, critical teacher, adaptable to different situations, MTE would not need to be constantly changing. Over the last two decades, research into mathematics teacher professional development has built up the profile of the adaptive, critical and reflective teacher. In this perspective, the teacher makes his or her own decisions taking into consideration the context in which the teaching takes place. Both awareness of the context and teacher autonomy play an important role. Within this paradigm, the teacher regards him or herself as an authority, with the capacity "to evaluate different perspectives in terms of what he or she values and considers to be empirical evidence" (Cooney et al., 1998, p. 312).

Some training experiences have empowered teachers to adapt to crises such as COVID-19. Ramploud et al. (2021) show the effects of a formative strategy based on lesson study framed in a perspective of cultural transposition. According to them, this perspective "is aimed at giving teachers, who have come into contact with teaching practices from different countries, the opportunity to become aware of their own unthoughts" (p. 4) (including cultural beliefs about teaching and learning). The goal is the emancipation of teachers to make educational decisions based on their intentions. This training develops resilience skills ("such as finding one's educational intentionality and flexibly trying to find ways to design one's educational proposals corresponding to such an intentionality, even in unexpected situations" (p. 5)). Ramploud et al. present the case of a teacher and the dilemmas she faced in her experience during the COVID-19 outbreak, in which flexibility became central. This goal of emancipation in this study closely parallels that of autonomy in Cooney et al.'s (1998) analysis. Both of these studies draw attention to the importance of (future) teachers reflecting on their assumptions if the goal of becoming an adaptive teacher is to be achieved. These assumptions include both how they see themselves as teachers, and how they understand the social and cultural parameters within which they must act. The aim is to make teachers as aware as possible of these constraints, and to understand when it may be necessary to change them.

Some of the voices advocating that both mathematics teaching and MTE must be adapted to emerging critical problems, such as the COVID 19 pandemic, call for teacher training to foreground certain mathematical content (such as graphics, statistics and modelling). Recognizing the importance of these contents to understand the current world, if teachers reflect on the possible role of mathematics not only to interpret and respond to crises, but to create and shape them as well (Skovsmose, 2021), they can

contribute to producing educated citizens capable of understanding and engaging more humanely in problematic situations.

Given that teachers will have to deal with different situations of change, it is essential that they become aware of their training as a continuous process, which begins in initial training and lasts throughout their professional life. This reinforces the desirability of training models for both preservice and inservice teachers that foster shared learning based around practice (Carrillo et al., 2020). Such models emphasize for both preservice and inservice teachers that foster shared learning based around.

A global world

When we refer to a rapidly changing world, we think of a global world where problems are evenly perceived and given equal importance across the planet. To what extent is this an unquestionable and positive assumption? Not all problems are equal; some are deemed to be crises while others are considered local (Skovsmose, 2021). However, in a particular place, a local problem may be more critical to its population than a global one, and so-called crises can be identified as such because they affect richer and more powerful countries. The global perspective may imply, in addition, a standardization of MTE without considering the local needs of mathematics teaching (Gellert, 2021). MTE, then, should not only be guided by global problems; rather MTE needs to make (prospective) teachers aware of the importance of local issues relating to mathematics.

Teacher education can only provide local answers

While MTE needs to be adapted to social and cultural changes, some of which may be common in different places, the answer must consider the particularities of where such education takes place. There is no global consensus of what is effective mathematics teaching, and perhaps such an aim is even undesirable. While western countries are generally agreed on approaches that emphasize student centeredness and inclusiveness, "how relevant for other settings are our western understandings of effective mathematics pedagogy?" (Walshaw, 2014, p. 299). Global approaches to mathematics education may involve a new type of colonialism, imposing certain perspectives on national educational policies (Schubring, 2021). These perspectives are often a reflection of the hegemony of Western states. Therefore, a uniform global response in terms of MTE is not desirable. Research has revealed important differences in MTE even in geographically, historical and political close countries, as the Czech Republic and Hungary (Novotná et al., 2021). These authors explain that similar questions are not always answered similarly.

Conclusion

Refuting the claim that MTE should be responsive to a rapidly changing world is not to say that education programs should insulate themselves from what is happening in the world at large. Teacher training, and mathematics teaching itself, must evolve and adapt to changing circumstances. But we must also be aware of two considerations in doing so. First, given the difficulties and differences involved in orchestrating a rapid

response, would it not be better to focus our attention on the core features of crisis situations, and on a stable teacher profile, such that MTE remains consistent over the medium term, rather than undergoing constant change? Such an orientation is achievable if our teacher profile is that of a flexible professional, who recognizes that the underlying cause of the majority of crisis situations is inequality. Second, the world is variegated, and mathematics teaching and MTE are highly context dependent activities. Both the identification of the issues meriting a response, and the capacity and means to do so, should be considered from a situated perspective. We must be alert to the dangers of inadvertently furthering the interests of the most powerful, and establishing a standardization of MTE and hence of mathematics teaching.

MATHEMATICS TEACHER EDUCATION IN AN EVER-CHANGING WORLD (JAGUTHSING DINDYAL)

This section of the paper argues against the motion: *Mathematics teacher education should be responsive to a rapidly changing world*. In this section, teacher education refers to the structures, institutions, and processes by means of which people are prepared for work in elementary and secondary schools, including preschool and kindergarten (Taylor, 2016) and the education of both preservice and inservice teachers is included. Teaching is viewed as "a complex practice and hence not reducible to recipes or prescriptions" (National Council of Teachers of Mathematics [NCTM], 1991, p. 22) and "The quality of an educational system cannot exceed the quality of its teachers" (Barber & Mourshed, 2007, p. 16). In addition, MTE, in any country, is considered as being embedded in specific socio-cultural, economical, political, and ideological contexts that limit rapid and frequent changes to its nature and content.

How do we see MTE?

Does MTE have an independent existence? MTE is not a separate entity. It is not tangible but is an underlying process that can be perceived or sensed in a timeframe in any country. MTE is identified with the school mathematics curriculum. Accordingly, it is contextual within each specific socio-cultural and socio-economic environment. as advocated by Apple (2001) who claimed "teacher education does not stand alone. It is deeply connected to more general tendencies in educational politics" (p. 183). Most importantly, both mathematics education and MTE in any country are in the political domain where important decisions about mathematics curriculum and MTE are made by the policy makers. Apple (1992) added that "mathematics education exists as part of the larger curriculum" (p. 429) and as such, policy decisions about general education impact mathematics education and certainly impact MTE as well. Very often financial priorities affect the quantum of the GDP allocated to education and as such to MTE. In view of the current pandemic, Schleicher (2020) has reiterated that our capacity to react effectively and efficiently in the future will hinge on governments' foresight, readiness, and preparedness, which connects clearly with policy decisions about MTE.

The decision about what to change and what not to change following changes in the world resides with the policy makers in each country. We know that policies take time to change. As such, we cannot change the mathematics curriculum and the concomitant MTE curriculum too rapidly. Do countries have the ability and resources to respond to MTE following rapid changes in the world? Schleicher (2020) reports that funding in many countries have been diverted in the health sector and the economy. How fast can universities and other similar institutions responsible for MTE bring about rapid changes in the MTE curricula?

Stigler and Hiebert (1999) have highlighted that teaching is a cultural activity. There is a uniqueness about culture in all countries that hinders it from being modified or changed rapidly. An important aspect is the value system that is so unique to a country. It takes time for values to change or be modified in some ways. Even within the same country, educational initiatives from the federal government and other national bodies are viewed with a lot of suspicion by state authorities. For example, in the U.S., proposals for reform by the NCTM led to the so-called *Math Wars* between the *Mathematically Sane* and the *Mathematically Correct* groups. So, imagine what will be the issues if individual countries started to respond to all types of proposals for change in their MTE, based on "rapid" changes in the world.

Rapidly changing world: Myth or reality?

The notion of rapidly changing world is not an issue in the sense that the world has always been a changing world as exemplified by this quote from the Greek philosopher Heraclitus who has proposed: *"There is nothing permanent except change" or the equivalent idea that "We never cross the same river twice". This implies that the notion of a changing world, however significant, is not new as we have always dealt with this idea in one way or the other. Examples pertaining to the mathematics curriculum and the corresponding effect on mathematics education worldwide include:*

- *There were reforms embodied in the New Math movement of the 1960s, the back-to-basics in the 1970s, the problem-solving movement in the 1980s and the standards movement in late 1980s and 1990s. Although these happened mainly in the U.S., their repercussions reached all parts of the world.*
- *Influential reports such as the Cockcroft Report (1982) of the UK also impacted MTE worldwide, given the considerable number of past British colonies.*
- *Theories about how students learn mathematics which started mainly in Western countries: behaviourism, guided discovery, and constructivism have influenced mathematics education and certainly impacted MTE worldwide. There were even proposals for using teacher-proof approaches in schools.*
- *Data from the international comparative studies such as TIMSS and PISA, unexpectedly, showed much higher levels of performance from countries in South East Asia as compared to Western countries and debunked some myths about class size, and teaching approaches and led to several countries adopting curricula published elsewhere.*

- *Influential books such as The teaching gap (Stigler & Hiebert, 1999) emphasized the idea that teaching is a cultural activity and highlighted lesson study approaches used in Japan, especially, to the Western world.*
- *Advances in technology which led to the use of calculators, graphing calculators, CAS and DGS also influenced the mathematics curriculum and de facto, the MTE programs worldwide.*
- *Recent initiatives such as STEM education are already affecting mathematics education in many parts of the world, with several issues (Bakker et al., 2021).*

So, there have always been changes in mathematics education in parts of the world to which the rest of the world has been responding for good or bad based on their own local policies and available resources. So, what are these rapid changes that we should be reacting to? What guarantee do we have that these so-called rapid changes are not market driven to exploit countries worldwide? We have to be extremely careful, as Apple (2001) cautioned, that as "market-based approaches are growing internationally, there are concomitant moves to create uniformity and a system of more centralized authority over what counts as important teacher skills and knowledge" (p. 183).

What does "should be responsive" mean?

There is a lot of vagueness associated with the term "responsive". Are we talking about a significant review of the MTE curriculum? Are we suggesting massive retraining/re-education of teachers each time there is what we (or a group of people or institutions) consider a major change in the world? If so, where is the funding coming from? In many countries funding for education has been directed away from education to other so-called priority sectors by governments worldwide (see Schleicher, 2020). Recent experience with the pandemic shows that we are not prepared but the main issue with the pandemic affecting classroom practice was that schools were in a state of lockdown. There was no physical classroom and so the need was for a virtual mode of delivery through a teaching platform such as Zoom or Microsoft Teams for which teachers had not previously been prepared for in most countries. Inaccessibility of the classroom seems to be the main issue and not the CK, PCK, or MPCK of the teachers.

MTE has to be certainly responsive to changes in the local environment and that the way it has been in all countries, whether there is a single institution (as in small countries) or several institutions (as in larger countries) involved in the preparation of teachers. MTE is not seen as perfect in any situation. It is in a state of flux, always changing and adapting to local needs of the curriculum as and when there are changes in the curriculum. There is still much to be done locally in improving the relevance of MTE in any country. To what extent can countries deploy their limited resources to counter or adapt to so-called rapid changes in the world? Who decides what is a global change or a global issue? Are we not advocating some kind of uniformisation of teaching practices across different countries? (see Apple, 2001) Also, focusing only on MTE does not make sense without any concomitant focus on the broader mathematics

curriculum, actual delivery of lessons and, perhaps most important, students' learning. So, why not focus on initial teacher preparation? As Barber and Mourshed (2007) stated, "Teachers develop the bulk of their instructional capability during their first years of training and practice" (p. 28). As such, having better preservice MTE can develop more versatile teachers who are more adaptable to new changes.

Other than in extreme cases such as epidemics, wars and environmental issues, which may affect the basic needs of human beings worldwide, MTE has always existed in a changing world. The notion of rapidly changing world is not clear and the idea of being responsive is vague. MTE has always tried to be relevant to local needs in all countries. Rather than continually changing MTE it is suggested that more resources be directed to get the right people to become teachers, develop them into effective educators, and ensure that each child gets the best possible instruction (see Barber & Mourshed, 2007).

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