DISCUSSING MATHEMATICS TEACHER EDUCATION FOR LANGUAGE DIVERSITY

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As part of a large research project about supporting preservice teachers to learn about teaching argumentation for critical mathematics education in multilingual classrooms, we outline a framework for considering the knowledge, skills and practices that we, as teacher educators, consider mathematics teachers need. Our objective for describing such a framework is to provide a discussion document for teacher educators, primarily at our institution, but also for others who aim to improve their mathematics teacher education practices and want to determine theoretically how to navigate the complexity of changing our practices.

TEACHER EDUCATION AND MULTILINGUAL MATHEMATICS CLASS

Recently, we were funded to investigate how the compulsory mathematics teacher education courses for Grades 1-7 at our institution could be improved so that preservice teachers learn appropriate knowledge, skills and practices to teach argumentation for critical mathematics education (LATACME) in multilingual classrooms. We consider that aspects of the project are likely to be relevant for other programmes, both in Norway and elsewhere. In Norway, preservice teachers have complained that they are not receiving adequate input about how to teach subjects, such as mathematics, in multilingual classrooms (Thomassen, 2016). Internationally, there is an awareness that mathematics teacher education programmes should include understandings about how to work with language diversity at the school level (see Aguirre et al., 2013; Essien, Chitera, & Planas, 2016; McLeman, Fernandes, & McNulty, 2012; Thompson, Kersaint, Vorster, Webb, & Van der Walt, 2016). However, research has shown that it is difficult to provide programmes that situates language diversity as a resource and challenges preservice teachers' deficit views about language diverse students (de Araujo, I, Smith, & Sakow, 2015; McLeman et al., 2012; Taylor & Sobel, 2001).

In this discussion paper, we set out our assumptions about the knowledge, skills and practices that preservice teachers need for working in multilingual mathematics classrooms. It is important that we clarify our assumptions in order to interrogate our research-based decisions about how to adjust both teaching and research. In the next section, we describe a framework that sets out our assumptions. We, then, describe the background for each of the different components.

THE LATACME FRAMEWORK

The LATACME framework (see Table 1) highlights two responsibilities that we consider teachers in mathematics classrooms have, focussing on their relationship to argumentation for critical mathematics education for multilingual students. To fulfil

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these responsibilities, we consider preservice teachers need to take on three specific roles: teacher; learner; and advocate.

Responsibilities / Roles	Facilitating the exploring and learning of mathematics	Facilitating the exploring and learning about the world through mathematics
Teacher	Knowing how mathematical topics and mathematical argumentation can be developed where languages are considered a resource.	Knowing how to develop connections between critical mathematics education and argumentation.
Learner	Learning from multilingual students about their understanding of mathematical topics and argumentation.	Learning about critical mathematics education issues of interest and importance to multilingual students and their communities.
Advocate	Knowing how to provide input about mathematics education, including argumentation, to (multilingual) parents, school communities and government.	Knowing how to advocate that students need to use of mathematical arguments in order to explore the world.

Table 1: The LATACME framework: setting out the knowledge, skills and practices that preservice teachers need for working in multilingual mathematics classrooms

In the next sections, we first discuss the responsibilities and then the roles. Although, separated in this discussion, we considered that preservice teachers need to understand how they operate together. Working with the complexity of mathematics education is necessary in order to achieve "morally informed and committed action" (Hardy & Rönnermann, 2011, p. 464) that is valuable for both individuals and for society as a whole. We acknowledge that our descriptions use normative language, but hope that this does not deter these ideas being challenged.

RESPONSIBILITIES

Teachers have professional responsibilities to the students in their classrooms and to the investment that society makes in education. As generalist teachers in Grades 1-7, our preservice teachers need to combine specific mathematics-education responsibilities with professional responsibilities connected to other subjects and their holistic work as teachers. We consider that there are two mathematics-education-specific responsibilities connected to being teachers in Grades 1-7. The first is to facilitate students´ possibilities, including multilingual students´ possibilities, for exploring and learning about mathematics. This is linked to school mathematics acting as a gatekeeper for jobs and further study. The second is to do with supporting

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students to explore and learn about the world with mathematics, which we consider to be closely related to critical mathematics education. As Skovsmose (1994) stated, "the teaching and learning process should be oriented towards the goal of providing students with opportunities to develop their critical competence in the form of qualifications necessary for participation in further democratisation processes in society" (p. 61).

Mathematics continues to operate as a gatekeeper in many Western societies, in that mathematical qualifications are required for entry to further study or job opportunities (Ernest, 2002). Yet, immigrant students, including in Norway, have lower scores on PISA tests, particularly if they use another language at home than the language of instruction (Chiu & Xihua, 2008). Therefore, teachers have a particular responsibility for supporting immigrant students to have the best possibilities for gaining the requisite mathematical knowledge, including that of mathematical argumentation, to fulfil these gatekeeper requirements.

Mathematical argumentation is important in fulfilling this gatekeeper function because it is considered a core component of school mathematics, due to its strong connection to proof (Enge & Valenta, 2015) and because it is through argumentation that students show they have mastered the conventions of school mathematics and belong to the community of successful learners (Cobb & Hodge, 2002). In reviewing earlier research, Kleve (2015) suggested that not all Norwegian school students would have equal access to essential mathematical genres, what she called secondary discourses, because the students came with a range of different everyday conversation styles, or primary discourses, which were more or less in alignment with secondary discourses. Similarly, Kempert, Saalbach, and Hardy (2011) suggested that lack of fluency in the language of instruction could have an impact on bilingual students possibilities for understanding the "definitions, explanations, and argumentations" (p. 548) needed for solving mathematics word problems, which have a particular structure. Thus, there is a need for teachers to understand how some groups of students have their opportunities to learn mathematics reduced because of an unfilled need to systematically develop mathematical argumentation skills (Erath, Prediger, Quasthoff, & Heller, 2018) and that multilingual students bring with them existing language resources that can be utilised in their learning (Planas, 2018).

The second responsibility in the framework is about using mathematics to explore and learn about the world. In describing what he called "social empowerment", Ernest (2002) stated that learning mathematics should result in students being "able to understand and begin to answer important questions relating to a broad range of social uses and abuses of mathematics" (p. 6). Thus, multilingual students, like other students, need to learn to critique existing societal issues with mathematics and promote their ideas through argumentation. Yet, moving mathematical arguments into societal conversations is not straight forward (Aguilar & Blomhøj, 2016) and for some students the unfamiliarity of the societal contexts may affect their willingness to engage in these types of arguments (see for example, Lubienski, 2007). Students

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coming from an immigrant background may not have the same interest in or familiarity with the societal contexts chosen by a teacher.

As teacher educators, we need to discuss and clarify our understandings about the responsibilities of mathematics teachers for providing relevant mathematics education. At the same time, we accept that it is not easy for educators to resolve the inherent tension between the two responsibilities, described by Jablonka and Gellert (2010) as "a pedagogy of access and a pedagogy of dissent" (p. 43), nor for learners to gain both because of the high level of reflection required (Powell & Brantlinger, 2008). Still, it remains important for teacher educators to focus on this complexity through reflective discussion about: what constitutes school mathematics; what kind of outcomes it is supposed to achieve; what is said about it; how it is conducted; in which ways does it expect people to act towards each other (Franke, Kazemi, & Battey, 2007).

ROLES

In order for the responsibilities to be achieved, we consider that preservice teachers need to take on three roles: teacher, learner, and advocate. Each role contributes different sets of knowledge, skills and practices to mathematics classroom teaching.

Teacher

The role of teacher is the one that most preservice teachers would expect to have in mathematics classes (see for example, Meaney & Lange, 2012). The knowledge, skills and practices, needed for teachers to fulfil their responsibility to increase students´ possibilities to explore and learn about mathematics, has been labelled pedagogical content knowledge (PCK) (Hill, Ball, & Schilling, 2008). PCK consists of both knowledge of the subject, in this case mathematics, and knowledge of how best to teach that subject, such as awareness of misconceptions students might have and how to overcome them (Shulman, 1986). The content of teacher education courses is often discussed in terms of PCK, reflecting the idea´s origin as supporting teacher educators to determine what they should focus on with preservice teachers (Shulman, 1986).

Although preservice teachers´ mathematics content knowledge has been much investigated, less research has been done on the PCK that teachers need for improving school students´ mathematical argumentation in multilingual classrooms, particularly in regard to using students´ multiple languages. Enge and Valenta (2015) found that Norwegian preservice teachers struggled with providing appropriate mathematical argumentation because they did not define the mathematical objects or seemed able to choose and use appropriate representations, such as algebra, in their argument. A lack of clarity about their own mathematical argumentation could affect the possibilities they offer their students for exploring and learning mathematics. This could be the case for multilingual students, whose needs and language resources may be different to their monolingual peers, which Planas and Civil (2013) described as

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the tension between "the simultaneous need to reinforce and improve the language of instruction and that of sharing knowledge in the home dominant language" (p. 374).

Based on research done in Māori settings, Meaney, Trinick, and Fairhall (2011) used PCK to identify the knowledge that mathematics teachers need about language diversity. We adapted their points about the inclusion of language issues in mathematical PCK to highlight how PCK could relate to mathematical argumentation:

- Knowledge of mathematical language argumentation
- Knowledge about students' mathematical argumentation including how to use students´ multilingual language resources
- Knowledge about teaching mathematical argumentation to (multilingual) students which utilised their current languages as resources.

The knowledge, skills and practices connected to teaching argumentation also include knowing about how resources such as digital technologies can affect the possibilities for mathematical argumentation. For example, Wegerif (2004) found that ICT can facilitate and direct students´ mathematical arguments towards subject matter learning and Wegerif and De Laat (2011) argued that ICT can be seen as a facilitator opening and shaping spaces for argumentation that otherwise would not be there.

Nevertheless, we do not consider PCK, as it is commonly defined, as adequate for addressing the second responsibility of supporting students to explore and learn about the world using mathematics. In fact, PCK can over-emphasise the importance of learning mathematics only for the gate-keeper function. In summarising research on critical mathematics education, Meaney and Lange (2013) identified several examples where teachers and students resisted the inclusion of real-life experiences into discussions because they considered the only valid arguments were mathematical ones. Therefore, teachers need appropriate skills, knowledge and practices that provide multilingual students with opportunities to explore their everyday experiences with mathematics. For example, as a result of a teaching intervention English and Watters (2005) found that young children could blend their everyday knowledge with their mathematical knowledge in developing arguments and justifications about modelling problems. This suggests that teachers can change their conceptions about including students everyday knowledge into mathematical argumentation. Thus, the specific needs of working within a multilingual classroom, where students have a range of backgrounds and experiences, require teacher educators to support preservice teachers to gain a broader range of teaching skills, knowledge and practices.

Learner

As well the role of teachers, preservice teachers have the role of learners, so that they can understand multilingual students´ mathematical thinking and the skills and knowledge they bring to both mathematical argumentation and argumentation that

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uses mathematics. Walshaw and Anthony (2008) emphasised that "a context that supports the growth of students' mathematical identities and competencies builds on students' responses, shapes the reasoning and thinking to an appropriate level, and moves ideas and solutions toward a satisfactory conclusion" (p. 539). As learners, preservice teachers need skills to identify what their students know as a basis for then developing their possibilities to explore and learn mathematics and the world with mathematics.

For multilingual students´ learning opportunities to appropriately utilise their cultural background, preservice teachers need to know how argumentation can be culturally shaped. Luykx, Cuevas, Lambert, and Lee (2005) noted the importance of understanding the impact of cultural communication patterns, "students from non-mainstream cultures often consider it rude or combative to address points made in the previous person's contribution, defend one's arguments with logic and evidence, or look for anomalies in another person's statement" (p. 127). Thus, finding out about multilingual students' language resources, including cultural understandings, is an important component in preservice teachers´ roles as learners. To confront stereotypes, preservice teachers need to learn from students and their families about their experiences and expectations so that their teaching will be better informed.

In order to fulfil the second responsibility, preservice teachers also need to gain skills, knowledge and practices to learn about students´ interests, which could be used as appropriate contexts for critical mathematics education. Political contexts have been identified as motivational for students´ learning mathematics, because "mathematics can be used to legitimise and justify political decisions that directly and significantly affect the social dynamics of some communities and the lives of their inhabitants" (Aguilar & Blomhøj, 2016, p. 257). However, in a review of research on ethnomathematics and critical mathematics (Meaney & Lange, 2013), the contexts used in mathematics lessons were almost always chosen by the teacher, based on assumptions about what students were interested in. As teacher educators who value the importance of the second responsibility, we need to assist preservice teachers to learn from their students, and their families, about their interests so that mathematics can add value to students´ learning (Trinick, Meaney, & Fairhall, 2017).

Advocate

Although rarely noted – PCK makes no mention of it at all – preservice teachers may need to be advocates for their multilingual students ´ rights to engage in mathematical argumentation and argumentation using mathematics in many different circumstances. As Anthony and Walshaw (2009) stated, "major innovation and genuine reform require aligning the efforts of all those involved in students' mathematical development: teachers, principals, teacher educators, researchers, parents, specialist support services, school boards, policy makers, and the students themselves" (p. 27).

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For example, Planas and Civil (2013) discussed how "students whose dominant language is not the language of instruction may withdraw from participating in whole-class discussions and defer to the students whose dominant language is that of instruction" (p. 375). Therefore, a teacher may need to advocate for multilingual students´ right to use the full range of their language resources with other students.

Given that accepting the second responsibility about the need for preservice teachers to provide students with opportunities to explore and learn about the world with mathematics is not generally perceived as part of mathematics education, there may be a need to advocate for teaching methods which emphasis the role of argumentation in multilingual mathematics classrooms. Research by Graue and Smith (1996) showed how established parental understandings about what constitutes mathematics education both affected their children´s views and were difficult to change. Graue and Smith (1996) strongly suggested that a more dialogic approach to implementing teaching reforms was needed. Yet, preservice teachers may not consider it their responsibility to instigate a dialogic approach by, for example, contacting parents outside of set parent-teacher evenings, in which the focus is mostly on students´ achievements (Meaney, 2013). Thus, their teacher education programmes need to provide them with alternative ways to advocate for new teaching practices with parents.

Preservice teachers may also need to advocate for their students in the wider society. In Scandinavia, Lange (2008) and Svensson, Meaney, and Norén (2014) documented how media discussions affected the views of teachers and the general public about multilingual students´ possibilities to learn mathematics. Therefore, teachers may need to learn how to raise alternative discussions in the public sphere about how and what multilingual students should learn in mathematics lessons.

Yet developing preservice teachers´ skills, knowledge and practices to be appropriate advocates for their multilingual students at all levels of education is not common in mathematics teacher education programmes. Therefore, there is a need for us, as teacher educators, to reflect on how they can make this part of what these programmes.

CONCLUSION

In this discussion paper, we have presented a framework (see Table 1) that outlines the knowledge, skills and practices connected to the responsibilities and roles that preservice teachers in our compulsory mathematics teacher education programme need so that multilingual students have the greatest chances for learning mathematics. As teacher educators, we need to discuss whether these are the knowledge, skills and practices needed by preservice teachers. Certainly, we must extend our expectations beyond preservice teachers relaying curriculum requirements if we are serious about multilingual students exploring and learning about mathematics and exploring and learning about the world through mathematics. We see the framework as providing opportunities to discuss whether other responsibilities or roles or other ways of

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thinking about our work as mathematics teacher educators would be more appropriate.

Discussions about the role and responsibilities as being more or less appropriate will only be the first step in instigating a teacher education programme that takes seriously the need to support multilingual students as having with them a range of resources connected to their languages, experiences and aspirations. Although previous research outlines the difficulties in changing our teacher education courses, we anticipate that this will be an exciting component of our upcoming research project.

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