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# **Introduction to the work of TWG25: Inclusive Mathematics Education – challenges for students with special needs**

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## **Introduction**

For CERME11, a new TWG about inclusive mathematics education has been established, with its first meeting at CERME11. This group was created due to an arising need for a forum to discuss issues of inclusion in the light of special needs in mathematics (SEM) in educational research. This branch of research has been developed in relation to general educational research about special educational needs (SEN) over the last decades, and has come to include not only disability and psychological issues, but also social, cultural and educational issues (Magne, 2006) Hence, the notion of SEM covers different epistemological fields as well as touching upon issues of normality (Skovsmose, 2019).

The scope and focus of TWG25 is hence SEM and inclusion, in the intersection of mathematics education research and special education research. Since this scope is broad, the TWG-papers compromised grades 1-12, teacher professionalization and teacher education programs, types of inclusive settings in mathematics, concepts and models for instruction and subject matter didactics, special educational needs and child characteristics, and content related decisions for inclusive mathematics education.

During CERME11 there were 17 participants in TWG 25 from 10 countries – colleagues from Europe, and also from Canada and Hong Kong. 10 papers and 2 posters were presented during the week, and the thematic schedule was oriented towards the topics of the submitted papers and posters (presenting authors below). The first session was spent on a discussion about the aims and objectives of this new TWG and an exchange of overarching issues of the situation of SEM in the different represented countries. In the following TWG-sessions, two or three papers were presented each time, under an overarching theme. The themes were: (1) *Development of materials, tools, learning arrangements, settings, etc.* (2) *Research on classroom situations, out-of-school situations* (3) *Research on teacher education (pre-service and in-service).*

The themes were discussed in the initial session in order to include all participants.

*(1) Development of materials, tools, learning arrangements, settings, etc.*

This theme includes discussions of how to develop tools to identify students in SEM, but also how to promote their learning, including the research aims: for example, seeking to know the place of mathematics education in dyscalculia research, how to reconcile approaches to reach a better understanding of the disorder and provide professional development activities for both, pre-service and in-service teachers, regarding the multicultural education and presenting all attributes of a designed learning software.

*Florence Peteers:* Diagnosis tools of dyscalculia – contribution of didactics of mathematics to numerical cognition

*Janka Medová:* Designing Mathematical Computer Games for Migrant Students

*(2) Research on classroom situations, out-of school situations*

This theme includes discussions of inclusion in relation to SEM students, mathematics classrooms and out-of school situations, where the focus lied in the challenges and possibilities in mathematics education. Examples of research questions within this theme are: How are inclusion and disability constructed in the discourses of teaching staff and pupils in mainstream mathematics classrooms? (paper Stylianidou & Nardi) How do SEM-students perceive their participation in terms of learning and teaching in an inclusive mathematics classroom to have optimal opportunities to learn? (paper Roos).

*Helena Roos:* I just don't like math, or I think it is interesting, but difficult ... Mathematics classroom setting influencing inclusion

*Laurie Bergeron & Audrey Perreault:* Strategies that promote the mathematical activity of students with language disorders: an analysis of language interactions

*Kinga Szücs:* Do hearing-impaired students learn mathematics in a different way than their hearing peers? Challenges and possibilities of cognitive enrichment in inclusive mathematics classrooms – a review

*Angeliki Stylianidou:* Mathematical discourses of a teacher and a visually impaired student on number sequences: Divergence, convergence or both?

*(3) Research on teacher education (pre-service and in-service)*

This theme includes discussions of inclusive education and SEM in relation to teacher education and teachers' views. How are teacher education programmes related to inclusion and what are adequate strategies for teachers to develop inclusive mathematical settings. Examples of research questions within this theme are: How should didactical courses in teacher education be designed to address the topic 'inclusive mathematics'? (paper Scherer).

What challenges do mathematics teachers experience when teaching students with mathematics learning difficulties in an inclusive classroom and what potential measure do they use? (paper Hamukwaya) What is the effect of improving the knowledge of braille display and Text-To-Speech synthesizer support of mathematics teachers on braille reader's achievement in mathematics? (paper Van Leendert)

*Petra Scherer:* The potential of substantial learning environments for inclusive mathematics – student teachers' explorations with special needs students

*Laura Korten:* An in-service training to support teachers of different professions in the implementation of 'inclusive education' in the mathematics classroom

*Chun-ip Fung & Dichen Wang:* Teaching mathematics to students with intellectual disability: What support do teachers need?

*Sarah Buró & Susanne Prediger:* Low entrance or reaching the goals? Mathematics teachers' categories for differentiating with open-ended tasks in inclusive classrooms

*Annemiek van Leendert:* Supporting braille readers in reading and comprehending mathematical expressions and equations

*Shemunyenge Taleiko Hamukwaya:* K-12 Namibian Teachers' Views on Learning Difficulties in Mathematics: Some reflections on teachers' perceptions

## **Introductory discussion – overarching issues of the situation of SEM**

The world is changing very fast and so are the demands on teachers. School classrooms are growing increasingly heterogeneous – with respect to language, culture and abilities. This requires differentiation with regards to learning goals, instruction strategies and individual tasks, to accommodate the classroom to enhance every students learning (Bishop, Tan, & Barkatsas, 2015).

Internationally, a trend is visible towards inclusion, a comprehensive school for all, where students with very different levels of abilities and different skills are educated together (Bishop et al., 2015). Some European countries have a very long tradition of inclusion, while in other countries it is relatively new, since students with more marked disabilities used to be educated in special schools. The change in the system generated a passionate discussion on the advantages and disadvantages that inclusive education brings, which reflects the negative attitudes that teachers might have towards inclusion (e.g. De Boer, Pijl, & Minnaert, 2011).

Inclusive education brings many challenges to schools. Often it is connected to a lot of administrative load in many countries. For example, some school systems and governments require detailed and individualized progress reports and education plans to include every student, and this has to be done in so-called multi-professional teams for which they might not be prepared (see Ritter, Wehner, Lohaus, & Krämer, 2018). All this applies to mathematics education, too. A mathematics teacher is expected to cope with the demands within the inclusive

classroom, to plan lessons where all students will receive appropriate support and challenge. At the same time, they often have to deal with more administration, and often with more rules and monitoring from the management or government. This could even lead to teachers feeling stressed and opposing the whole idea of inclusive education. Although large differences between countries exist, the problems are recognized to a smaller or larger extent in all countries. The work in TWG25 showed that there are ways that can help pre-service and in-service teachers and teacher educators to support these processes. If teachers are better trained for teaching in a heterogeneous classroom and have adequate tools, methods and techniques to make it work, they will be much more motivated and willing to support the system.

During almost all sessions in TWG25, one big question was circling, namely how do we understand inclusion in mathematics? Is it static? Is it depending on national and cultural settings? How do the teachers, the learners and/or the researchers describe and understand it? Do they understand it the same, or differently? Is the way, inclusion is understood affected by the perception of students *in* need, or *with* need? Is it dependent on the perception of the student? These questions are immersed and reflected (implicitly or explicitly) in the overarching themes that emerged from the discussions of TWG25, and described below.

### **Overarching issues of TWG25**

Research in the field of inclusive mathematics covers a wide range. This can be seen in the directions taken in research covering disability, psychological, pedagogical and didactical issues. It can also be seen in how research covers aspects on either societal level or classroom level working with notions such as equity and diversity (Roos, 2019; Kollosche, Marcone, Knigge, Godoy Penteadó, & Skovsmose, 2019), and several trends in mathematics instruction were presented in the papers of TWG25. All papers focus on some aspects of mathematics teaching and learning in relation to SEM and deserve due attention. During the TWG-sessions based on the paper presentations, the following points were discussed, especially how they are linked with each other.

#### **Inclusive system or special schools?**

As stated in the introductory part, there are countries where special schools have a relatively long tradition (e.g. more than 100 years in the Netherlands) (Evans, 2004). Their clear advantage is that the staff has a specialized knowledge to work with and help special needs children. The number of students in classes is relatively low and thus the teacher has the time to individualize work. These schools have been criticized in the past by the EU for their exclusive nature, and many countries extended or built up inclusive systems according to the realization of the UN conventions (see UN, 2006). Inclusive education means each child has the right to be educated in the local school. However, in some countries, there is still a debate whether this is for the benefit of the student.

#### **Teacher education in relation to SEM**

Depending on the tradition of inclusive education, SEM is taken into consideration to a greater or lesser degree in the mathematics classroom. In countries with a longer tradition the system has more experience and mathematics teachers are more experienced to take SEM into consideration in their teaching.

Without any doubt the education must adapt to the situation and much more attention has to be paid to special needs in mathematics – taking children with mental or physical disabilities, students in great access to mathematics or second language learners into account. These different directions are discussed in the TWG-papers by *van Leendert et al.*, *Hamukwaya*, *Stylianidou & Nardi*, *Roos*, *Szücs* and *Bergeron & Perreault*. Also teacher education needs to prepare fresh graduates to know possible methods, techniques, and activities that will enable them to differentiate and individualize lessons. Teachers must have the theoretical background knowledge about different disabilities, in addition to practical examples of how to manage the classroom, what activities to use are essential. With all these special competences, the different forms of knowledge, subject specific knowledge included, is essential (cf. Shulman, 1986). Teacher education should reflect the findings of current research on work with special needs children as this is a fast developing area. This is discussed in the TWG-papers by *Scherer*, *Korten et al.* and *Fung & Wang*.

### **Change of teaching and learning strategies?**

Does SEM imply using new teaching and learning strategies? Taking an inclusive standpoint in the classroom asks for differentiation and individualization of work and take the individual student as a point of departure as discussed in the TWG-paper by *Roos*. Then the teacher's role is changing to the role of a facilitator, to the role of the person who plans the lesson and activities and then monitors students' work and helps wherever is needed. One of the ways of allowing inclusive classes to learn is to focus on how tasks can be designed and used to differentiate between students of different levels, like the paper by *Buró & Prediger* shows. Teachers are not always aware what kind of adjustments are needed for the different levels amongst their students.

Another point of discussion is whether constructivist approaches could help as all students build their own knowledge in a way that is suitable for their needs. However, there is no clear empirical evidence that this is the best way to teach students in SEM as the research result might be contradictory (e.g. Chodura, Kuhn, & Holling, 2015; Scherer, 1997).

### **How can mathematics teachers be motivated to work with SEM?**

The issue of motivating teachers to work with SEM is essential. Inclusive education is reality and teachers must be ready to face it. If they are well motivated, they are more likely to cope with the situation well. This, and how to work with teachers and different methods to use is discussed in the TWG-papers by *Scherer*, *Fung & Wang* and *Korten et al.*

One way to motivate teachers is to equip them with such tools that they will feel confident enough when facing a heterogeneous classroom with students with very diverse educational

needs. Having diverse teaching methods and techniques that enable differentiation and motivation will help. Also having experience with managing a classroom where an assistant is present will help and will give the teacher the needed self-confidence. Not everyone is happy with having a “critical” eye in all lessons.

Another way to increase teachers’ motivation is providing them enough opportunities to improve their knowledge and skills in the area. Pre-service teacher programs must pay enough attention to the issue, and high quality in-service teacher training programs should be available. If possible they should be designed and run by a number of specialists from different areas (special pedagogues, psychologists, but especially experienced teachers of a particular subject).

Once methodology and techniques of work with special needs students become more widespread and results will be tangible, motivation of teachers will become easier.

### **Who is in SEM?**

The large heterogeneity of the students with special needs in mathematics was discussed in TWG25, ranging from low IQ to gifted, from specific learning disabilities like dyscalculia (discussed in the TWG-paper by *Peteers & Ouvrier-Bufferet*) to behavioral and developmental disorders, including students with different cultural backgrounds (as discussed in the TWG-paper by *Medová et al.*). Also teachers’ views on special needs as presented in the TWG-paper by *Hamukwaya* was discussed. The question arose why we use the term special, and what is perceived as ‘normal’ (see Skovsmose, 2019). Wouldn’t it be better to talk about heterogeneity and take the individual differences as norm?

### **Conclusion and further directions of TWG25**

Reflecting back on the arguments made in the papers of TWG25 and on the discussions, there are, as prior discussed, diverse issues concerning inclusion in mathematics education and challenges for students with special needs in mathematics. In the TWG-papers about development of materials, tools, learning arrangements and settings, arguments are made for both developing sustainable ways of identifying dyscalculia in mathematics education (paper *Peteers & Ouvrier-Bufferet*) and developing learning software for both, pre-service and in-service teachers (paper *Medová et al.*).

In the TWG-papers about research on classroom situations and out-of school situations the focus was on challenges and possibilities in the classroom from different perspectives. Strategies promoting mathematical activities in relation to students with language disorders were discussed: Too often teachers tend to reduce learning opportunities within mathematical tasks by focusing on their cognitive characteristics and behavior, although the reported research shows that if a teacher offers space for dialogue with students and questions them in order to trigger their mathematical activity it becomes a powerful driver of student activities in a classroom context where the teacher offers a space where all voices are legitimized (paper *Bergeron & Perreault*). Another issue in relation to how to work in classroom was how a classroom setting influences inclusion in mathematics, and the importance to consider how to plan the classroom to include

everybody (paper Roos). In relation to work in the classroom, mathematical discourses of a teacher and a visually impaired student were investigated highlighting the interaction teacher – student (paper Stylianidou & Nardi). Also a review highlighting the learning of hearing-impaired students and the challenges and possibilities of cognitive enrichment (paper Szücs) was discussed within this theme.

In the TWG-papers about research on teacher education the focus was on how teachers view inclusion and SEM, and how teacher education can work to help teachers work inclusively. The potential of substantial learning environments (Wittmann, 2001) for inclusive mathematics in relation to student teachers' explorations with special needs students were reflected upon with the conclusion of the importance to include such type of explorations and reflections of inclusion in the teacher education (paper Scherer). In relation to this, it was discussed how in-service training can support teachers of different professions in the implementation of 'inclusive education' in the mathematics classroom (paper Korten et al.). Support to teachers was also discussed in relation to teaching mathematics to students with severe intellectual disability (paper Fung & Wang), with the conclusion that it is mathematics that must be in the centre of attention when discussing SEM, something that may sound too trivial to consider, yet often too easy to overlook. The development, testing, and refinement of didactical action plans involves studying various phenomena and their corresponding mathematical meanings, which can only be done from within mathematics. Support to students by supporting teachers in relation to braille readers in reading and comprehending mathematical expressions and equations through specific instructions was problematised (paper van Leendert et al.). When looking into mathematics teachers in relation to inclusion and SEM the way teachers categorise for differentiating in inclusive classrooms were highlighted, problematising low entrance (paper Buró & Prediger). Also teachers' perceptions in relation to learning difficulties in mathematics was problematised (paper Hamukwaya).

The major question, still left to be answered, is how we understand inclusion in mathematics, and how we can have a common ground in research despite the diversity of research directions and cultural and national differences. Still, it is interesting to see that even if there are very diverse issues concerning inclusion in mathematics education, there are similarities too. This can be seen in the themes of the TWG-papers. Hence, there seem to be opportunities to build a common ground regarding inclusive mathematics teaching and challenges for students with special needs. enrichment in inclusive mathematics classrooms.

Looking forward to CERME12 the community got a challenge to build further on the work at CERME11 and build a common ground to address issues within the scope of TWG25.

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