An introduction to TWG25: Inclusive mathematics education – challenges for students with special needs

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Inclusive mathematics education is a complex and multifaceted, under-researched area where research often requires collaboration between various fields of study – mathematics education, special education, pedagogy, psychology, etc. The Thematic Working Group 'TWG25 – Challenges for Students with Special Needs', established in 2019, is one of the platforms opening up space for collaborative research in this area. This means that TWG25 embraces research in very different fields of mathematics, research from the point of view of teachers, pupils, teacher education and classroom practices at all school levels from preschool education to upper secondary, even university level. The presented papers and posters give the opportunity to share but also to grow aware of what the field of inclusive mathematics education involves in an international context. Apart from the topics of the single papers and posters more general questions of inclusive mathematics are discussed in this introduction.

Keywords: Inclusive mathematics, special education, teacher education, classroom practices, beliefs.

Introduction

The Thematic Working Group 25 "Inclusive Mathematics Education – Challenges for Students with Special Needs", established for CERME11 in 2019, ran for the third time at CERME13. The scope and focus of TWG25 is on research about inclusion and special educational needs (SEN). It addressed the area where at least two research fields intersect – mathematics education and inclusive education or special education. The presented papers targeted inclusive education on primary and secondary levels, analysed types of inclusive settings and moments of inclusion, interaction and participation in inclusive mathematics classrooms, collaboration of teachers in one classroom, work with gifted children, pre-service and in-service teachers' beliefs and attitudes in connection to inclusion, creativity of special needs children, and more.

During CERME13, TWG25 had 17 participants from 10 countries (Austria, Czech Republic, Estonia, Germany, Greece, Israel, Italy, Sweden, Turkey, UK) who presented 12 papers and 2 posters. The size of the group allowed time for deep discussions. The first session of the conference focused on the aims and objectives of this TWG and an exchange of overarching issues of the situation of SEN in mathematics education in the different represented countries (the outcomes of this discussion will be discussed in the following sections). The following three sessions gave space for authors to present their papers, and in the follow-up discussion gain new perspectives and ideas for possible continuation of their research or

on the focus of their papers. The fifth session was designated for authors of posters to present their on-going research and get feedback on that. Sessions 6 and 7 allowed further deep discussions of themes that came up in the presentations as well as the opportunity for getting feedback from everybody in the thematic working group on each contribution. Shared documents were used to provide space for written feedback. Moreover, overarching themes of TWG25 were discussed as well as perspectives for future research (see below).

In detail, the sessions for presentations were arranged according to the following thematic focal points:

Research at the classroom level (primary education)

Session 2 included research on participation and cooperation within inclusive classrooms, the concept of participation and how it can be achieved and supported among learners in an inclusive primary classroom, moreover research on creativity and fostering creativity of learners with special needs, and finally research on the issue of basic mathematical competences that are essential for any later mathematics, and how to help learners at very early stages to master this fundamental competence. The following papers were presented and discussed:

Michael Gaidoschik: Inclusive teaching for part-whole understanding: a case study and related considerations on framework conditions

Yola Koch: Participating in inclusive classrooms by solving tasks in practical contexts and with objects of representation

Maya Ron Ezra & Esther Levenson: Expressing mathematical creativity: the case of mediating open-ended tasks for students with learning disorders

Anna-Maria Billigen: Cooperation processes in inclusive learning settings with a special focus on mathematical potentials

Research at the classroom level (primary and secondary education)

The third session included yet again the theme of participation, interaction, and communication in inclusive mathematics lessons as well as the development of the ability to "speak mathematics" and explain it. In addition, it encompassed research on work with learners with hearing impairment. One of the presented research projects focused on the development of suitable materials for learners with special needs at the lower secondary school level. The following are the papers that were the subject of this third session:

Sebastian Kollhoff & Kerstin Gerlach: Collective mathematical argumentation in the in-between of inclusion and scientific convention

Alexander Goldschmidt & Susanne Prediger: How can the double number line promote students with mathematical learning difficulties to conduct and explain proportional reasoning?

Liina Malva & Triin Kivirähk: Developing differentiated algebra worksheets for inclusive classrooms

Marc Sauerwein: Silent videos in heterogeneous classrooms as impulse for the development of mathematical notions exemplified on "What is a tangent?"

Research on teacher education (pre-service and in-service)
The fourth session focused on inclusion from teachers' perspectives. The papers focused on in-service teachers' ability to identify gifted learners but also on more general issues of what exactly inclusion is, what it means to pre-service and in-service teachers, what their beliefs, attitudes but also tensions and insecurities are in this area. Questions focusing on teachers' beliefs are substantial as in the end it is teachers who actually enact inclusion in classrooms. The following papers were presented and discussed in this session:

Jennifer Bertram & Petra Scherer: Which factors do pre-service teachers consider most important for successful inclusive mathematics classrooms? Results of an interview study

Caroline Hilton, Joel Kelly & Pete Wright: How teaching mathematics for social justice can support inclusive practices in the elementary mathematics classroom

Zeynep Özel, Mine Işıksal Bostan & Reyhan Tekin Sitrava: Mathematics teachers' professional noticing of gifted students' mathematical thinking within the context of pattern generalization

Maria Vasilopoulou & Chrissavgi Triantafillou: Tensions in teachers' attempts to apply inclusive mathematics education for students with diverse learning needs

Research on teacher education (pre-service and in-service)
The posters presented in Session 5 also focused on teachers and their practices, on situations when learners participated in the lessons in contrast to situations when it only seemed they were participating and what the teachers did differently, as well as what teachers themselves define as equity and inclusion. The two posters presented and discussed were the following:

Malin Gardesten: Students' participation in mathematics in inclusive settings

Helena Roos & Anette Bagger: Moments of inclusion and equity in mathematics education

Although all presentations had a specific topic, focus, or research approach, connections of research findings and results were discussed.

Introductory discussion – inclusive mathematics education in different countries

In the participants' countries we can see various trends regarding inclusive mathematics education. The trends we can observe reflect our growing heterogeneity with respect to language, culture, and abilities of learners in the classroom (see Bishop et al., 2015). This has been even more visible in the current migrating era in Europe (see e.g., Ulovec & Novotná, 2021). This naturally places new demands on the teachers of mathematics who must be able to cope with these rapidly changing conditions, often without having enough training, personal experience, and resources, or self-confidence to handle it.

What seems to be the case in many of the countries: inclusion is a decision of the policy makers pressuring schools and universities to adapt to it – in the schools as well as by introducing new teacher education programmes or enhancing the existing ones. At the same time, the area seems to be under-researched, leaving educators and teachers with little solid grounds to build on. The area of inclusive practices in mathematics deserves considerable research attention. The difficulties researching inclusive

mathematics education are many, starting from the fact that the terms inclusion and inclusive mathematics education are still not unequivocally defined; in fact, it seems that it means something different in different countries, regions, schools, and to individual teachers (Roos, 2019). This makes international – as well as national – research difficult.

The same can be said about many of the terms used by researchers in inclusive mathematics in different countries such as "learning environment". Wittmann's (2021) concept of "substantial learning environments" as a type of comprehensive tasks that are mathematically rich, often with open-ended outcomes, and that can be worked on at different levels, is not universally known around the world, and for some researchers "learning environment" includes the physical setting in the classroom.

For all these reasons, the initial discussion in TWG25 focused on the differences in organization of inclusion in the participants' countries. It showed many similarities but also a lot of variations. There are countries where there is only one comprehensive school for all learners, and (almost) all children are included in regular classrooms (Italy, Sweden). In many countries there are special schools for children with specific impairments (schools for visually impaired children, children with autism, children with hearing impairment, etc.). For example, in Germany the system of special schools and inclusive schools still coexist. Also in the Czech Republic, the system of special schools and inclusive school still coexists but special schools get less support and may be perceived as tolerated, e.g., they cannot get financial support from European projects. In countries such as Israel, there are also special education classes within mainstream schools. In most countries it is the parents who make the final decision about which school their child is going to attend.

The discussion showed there are differences in *who* "diagnoses" a child as in need of educational support, *when* a child is diagnosed, *at what stages* children get the support and *what form* this support takes. In Sweden for example, diagnosing a child as a general special needs student is in the hands of the teacher and the school. Though, to get a specific diagnosis such as ADHD or dyscalculia, a professional outside the school needs to do the investigation. In many countries like, e.g., Italy or the Czech Republic, children are diagnosed by special educators and/or psychologists outside of school, often using standardized tests. The diagnosis of special needs then might allow the school to give the child additional support, including having a special teacher, an assistant teacher or a teacher's assistant in the lesson.

However, even if additional resources are made dependent on the kind of diagnoses made, a diagnosis does not always lead to additional resources, for various reasons. In Italy, e.g., class teachers only receive (or at least *should* receive; see below) support from a so-called integration teacher if one or more children in the class have been diagnosed with a "disability" of some kind. On the other hand, if a child is diagnosed with "dyscalculia" or any other difficulty classified by psychologists as a "school-related learning disorder", the school regulations make it the responsibility of the class teacher to meet the child's special learning needs *without* additional support (Gaidoschik, 2022).

Then there is the difference between *what should be* according to official regulations and *what is actually implemented*. In all countries in the TWG25 there is a shortage of qualified classroom teachers. As a result, many countries have set up programmes that result in persons teaching mathematics who do not

have the qualifications that those same countries originally set as a sine qua non for the job. The same is true for special education teachers. The lack of qualified pedagogical staff also means that support measures that were actually intended are only implemented to a reduced extent.

As far as there *is* additional support, it may take on various forms – from developing a special programme for a specific child adapting mathematical content to their needs, to having an extra person in the classroom to help the special needs student. The discussion among the participants showed that having an additional teacher in the class is demanding – financially for the country, personally, as there are not enough qualified special teachers in any of the countries, but also from the point of view of setting up good collaboration between the two teachers present in the classroom (their responsibilities and activities). In some countries like the Czech Republic, the support is given be a teacher's assistant, i.e., a person without university education in teacher training, usually with a course in being a teacher's assistant. This in reality means a continuous presence of another adult in the classroom who is not a highly qualified expert in the field of teaching. The class teachers need to learn how to cooperate with a non-teacher, how to manage their work, how to use their presence effectively for the benefit of everyone in the classroom so that the assistant can help more than "babysit". Needless to say, that most teachers do not get this training in managing cooperation with their assistant.

The special programme for a child is also developed differently in different countries. While in Israel a school has a team that collaborates on a programme for the child, in other countries teachers of subjects have to develop the plan respecting the recommendations from the institution where the child was diagnosed. All in all, more research is needed concerning the collaboration of teachers and work of multi-professional teams, focusing on the educators as well as on the learners (e.g., Brownell et al., 1997; Hunt et al., 2003).

The discussion clearly showed that inclusive mathematics is a very topical, yet very sensitive issue, stirring a lot of emotions in countries. As some of the research studies presented in TWG25 show, there are creative teachers who are able to face the challenge but a more solid insight into the area, good teacher education programmes and more cooperation between special education and mathematics education may help in the situation.

Overarching themes of TWG25

Although the different presentations elicited specific research foci, general themes and questions emerged. Both the teachers' and students' level – also in connection with each other – were addressed, and central topics emerged, as seen in the following:

- The first theme regards the role and need for knowledge of *basic concepts*, together with the question of how to support children with SEN to acquire them, and the question of how and to what extent mathematics education can support students to go further even if they do not have certain basic competencies. In the context of efforts to teach mathematics in inclusive classes, Wittmann (2015) refers to the "inner learning hierarchy" of arithmetic and warns that further learning at a higher level is bound to fail if the basic competences required in terms of content are not present. This leads him to call for common learning time for all children in an inclusive

classroom to be supplemented by what could be seen as "targeted exclusion" in the form of "learning groups". Within such a group, intensive remedial work on basic skills can be carried out with children who need it, regardless of the curriculum for the particular school level, and fully adapted to the learning needs of the individual child. It seems clear that implementing this demand would require far-reaching changes not only in the staffing and organisation of schools, but also in the formulation of curricula and expected learning outcomes, especially in secondary schools.

- Affective issues are also important. How can we attend to problems of motivation, or mathematical anxiety, that may have been caused by mathematical difficulties in early years, such as mathematical anxiety, and are likely to negatively influence the further learning of mathematics (Carey et al., 2016; Sorvo et al., 2017)?
- There is a need to not only focus on mathematical difficulties but to address gifted children, using the mathematical potential, or foster mathematical creativity in inclusive settings.
- How can we ensure access to mathematics? Different approaches like universal design for learning (UDL), explicit instructions, design of suitable learning environments were discussed, connected with the question how to facilitate collaboration, participation, and acceptance between students.
- It is important to not only consider teacher's knowledge, but also their attitudes, and beliefs, challenges and tensions, and empowerment. When we go deeper into important fields of research, it has been shown in various studies for decades that primary school teachers often do not like or even fear mathematics and suffer from math anxiety (e.g., Ashcraft, 2002; Beilock et al., 2010; Widmen & Chavez, 1982). Johnson and van der Sandt (2011) report that the same holds for teachers of special education. Similarly, mathematics educators often speak of their lack of knowledge of special education and deeper knowledge of psychology.
- With respect to the question of when to start to have a closer look at students with difficulties, and how to get early support for students in need, the question arose regarding what support students get when their teachers do not have a (mathematics) qualification.

For many of these themes the necessity of publishing convincing best practice examples was pointed out.

Conclusion and further directions of TWG25

Obviously, research in inclusive mathematics education faces many challenges that will have to be addressed. First of all, the field will need more precise definitions of its main concepts. It will also have to bridge the gap between research in mathematics education and special education because only collaboration of researchers in these areas can help the field advance. It is essential that special and primary education teachers share their expertise and knowledge with mathematics educators. Special needs of children in mathematics need to be paid as much attention as learning difficulties in reading and writing. Mathematics educators should clearly define the core competences a child needs to handle in order to be able to succeed in mathematics later. In general, collaboration between professionals from different areas should be promoted.

Another crucially important question is how to make sure that classrooms intended to be inclusive are not exclusive in the end. This can be described as in(ex)clusion (e.g., Valero, 2017) when aiming for inclusion creates exclusion. If the work in the classroom is organized in a way that different children work on different tasks meant to be fitting their individual needs and potential, this might result in children working alongside each other but not with each other in an inclusive way. This would clearly not meet the appealing idea of students working "not side by side but working together on the same subject at different levels", as formulated by Freudenthal (1974, p. 164; our translation). That is why attention of the research community is shifting to interaction, participation, and the study of what these truly mean.

There seems to be a lack of quantitative studies on a larger scale in the area. This may be because quantitative design is not suitable for when we discuss children with very special, unique needs. However, some kind of quantitative research would allow a more comprehensive overview in the area and might be helpful as a basis to convince school officials and school politicians. That is another challenge the field faces.

In summary, it seems to be crucially important to research inclusive mathematics and to share research results in an *international* community. Looking forward to CERME14 the community has a challenge to build further on the work at CERME13 and build a common ground to address issues within the scope of TWG25.

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