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Explicit instruction and special educational needs in mathematics in early school years

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This paper is an exploration of how an educational method, Explicit Instruction (EI), is used and reflected upon in research in relation to special educational needs in mathematics (SEM) in early school years. The current research front is put in relation to the Swedish curricula in mathematics and the Swedish school act (steering documents) to explore potential possibilities and challenges of the research findings in a Swedish context. The analysis was done in three steps: 1) a systematic search of research literature, 2) a content analysis of the literature 3) a relation of the results of to the steering documents. The exploration of the possibilities of EI displays that EI can contribute to every student's learning by providing a distinct structure in relation to the mathematical content. It displays challenges for special education in mathematics regarding collaboration between teachers, the competence of teachers, and time to plan the EI and time for the students working with EI.

Keywords: Explicit instruction (EI), early years, special educational needs in mathematics.

Introduction

In a systematic literature review of research on special educational needs in mathematics (SEM) explicit instruction (EI) emerged as a common educational method to support and accommodate primary school teaching in mathematics focusing SEM (Bagger et al., 2019). SEM is in this paper interpreted as a socially situated and context-dependent need of educational adjustments in the mathematics education (Bagger & Roos, 2015). In the context of this paper this implies that even though some of the research found in this study has a different perspective on SEM, we view it in the lenses of being socially situated and context dependent. Regarding the notion of EI, it is a notion used in different fields of educational research and in different educational contexts and hence defined somewhat differently depending on where it is used. Though, at its core is a systematic instructional approach of pedagogical instructions. In mathematics education this systematic instruction is used to promote students' conceptual and procedural understanding with fluency (Doabler et al., 2018). In this paper EI is interpreted as a systematic instructional approach of pedagogical instructions in mathematics education to promote students' conceptual and procedural understanding with fluency. EI could be of special interest for SEM since it focuses the need to adapt the education according to every student to promote mathematical understanding. Following, the overall aim of this paper is to explore and discuss EI in relation to SEM, and to contribute with knowledge regarding EI's possible application in a school system, in this case the Swedish school system. To be able to do this, this paper puts the current research front of EI in relation to the Swedish curricula in mathematics (The Swedish National Agency, 2019) and the Swedish School Act (SFS 2010:800). Here an exploration

of the potential possibilities and challenges of research findings in this specific context is made. This exploration is made with the help of the research questions of the paper: a) How is EI depicted in research in relation to SEM? b) What are the challenges of using EI in relation to meet SEM students' needs in the Swedish school system?

Setting the scene – Swedish mathematics education

This section describes the Swedish setting in which this study is situated. Compulsory school in Sweden starts at the age of 6 when children start preschool class and start being taught mathematics. There is a national curriculum, Lgr 11 (The Swedish National Agency, 2019), from preschool class and all through compulsory school (students aged 6-15). The Swedish mathematics curriculum does not in detail regulate the teaching and learning content, materials, or methods. Rather, it regulates what areas in mathematics are to be covered in the teaching, how to approach and understand students' learning, and what knowledge, competencies, and abilities education should stimulate: "Teaching should aim at helping students develop knowledge of mathematics and its use in everyday life and different subject areas." (The Swedish National Agency for Education, 2019, p. 55) According to the curriculum, the teaching in mathematics shall give the students opportunities to develop five abilities: Formulate and solve problems using mathematics and also assess selected strategies and methods, use and analyze mathematical concepts and their interrelationships, choose and use appropriate mathematical methods to perform calculations and solve routine tasks, apply and follow mathematical reasoning, and use mathematical forms of expression to discuss, reason and give an account of questions, calculations, and conclusions. (The Swedish National Agency for Education, 2019, p. 56)

Looking at how much time students are spending in mathematics education in Sweden according to the Swedish School act (SFS 2010:800), students in lower primary school shall have 420 hours of mathematics education during their three years, and in upper primary school 410 hours.

Most mathematics teachers in primary school are general teachers. Many schools have a special teacher in mathematics employed. The special teacher works as a consultant to teachers, works with smaller groups or individual students, and sometimes co-teaches in the classroom.

Special educational needs in mathematics (SEM)

In this paper, EI is investigated in relation to SEM and the Swedish steering documents. Hence, this section describes how SEM is defined and used in a Swedish context. In relation to SEM and the context, it is important to consider that the interpretation of special educational support is always situated in culture and time, meaning the interpretation and use of the term "special needs" itself "depend[s] ultimately on value judgments about what is important or desirable in human life and not just on empirical fact" (Wilson, 2002, p. 61). The writings in the Swedish School Act (SFS 2010:800) that regulates special educational support, show that it is highly situational and relative if a student is considered to need special support or a milder form of support that is basically extra adjustments of the regular learning environment. When connecting special support to the school subject of mathematics, the judgments of special support concern how the education can help the student get access to knowledge development in mathematics (Roos, 2019).

SEM is a notion hard to define and is defined differently depending on in which situation it is used and from what epistemological field it derives (Bagger & Roos, 2015). For example, if it is used within the psychological field most often it is referred to as an individual deficiency (e.g., Pitchford, et al., 2018) but if it is used as a notion describing a specific need in mathematics education to meet diversity, the institutional environment in where it is situated is most of interest (Roos, 2019). Bagger and Roos (2015) suggest using the notion of "special educational needs in mathematics" to apply a social-relational perspective, which is adapted from Magne (2006) and used in this paper. This implies a socio-relational perspective on learning when we explore IE as a teaching strategy for the benefit of SEM students studying under the Swedish curricula.

When looking at the Swedish curriculum (The Swedish National Agency for Education, 2019) and Swedish School Act (SFS 2010:800) regarding SEM and inclusion, even though the word inclusion is not used, there are governing functions of inclusion (Roos, 2021). These functions can be described as discourses, Discourse of Democracy and citizenship, Discourse of equity, Discourse of Possibilities for participation and access, and Discourse of Knowledge and assessment in mathematics. When looking at the described Discourses, their functions are mostly ideological, and there appears to be a gap to how to actually do inclusion in the education (Roos, 2021) and how to actually work with SEM.

The analysis process

This section describes the analysis in this paper, which was done in three major steps. The first step was a systematic search of research literature to find how the current research front in SEM uses EI. The second step consisted of a content analysis of the selected research literature and the third step was to put the results of the content analysis in relation to the writings in the Swedish national curriculum (The Swedish National Agency for Education, 2019) and the Swedish school act (SFS 2010:800).

In step one, to not miss out on research in SEM using EI we searched broadly in four databases that focus on pedagogical and educational research both international and national: ERIC, Scopus, Web of science, and MathEduc. The keywords were chosen to have a broad focus on SEM and education: *disabilit** and *math** and *learning** and *education** and *difficult*. From here we could see which of them had research concerning some systematic instructional approach of pedagogical instructions in mathematics. The search resulted in 90 articles with no overlaps between the databases. To limit the result, we added a timespan of the last ten years to focus on the current research front. Also, only articles written in Swedish, or English were selected since we are fluent in those languages. Another limitation was that the articles needed to be published in peer-reviewed journals and focus on students from 6 to 12 years old. This left 58 articles to review. 21 out of these articles somehow discussed or used EI in relation to SEM and thus were selected.

In step two, in the reading of the selected research articles, we applied a content analysis inspired by Feucht and Bendixen (2010) to identify and categorize how EI is used in the context of SEM. Here statements about EI in the research texts were identified and summarized. This identification and summarization allowed for themes to emerge. Through the identification, categorizations were made

which resulted in four themes: *systematic instructional approach of pedagogical instructions in mathematics education, word problems, mathematical representations, and working memory*.

In step three we studied the themes that emerged from the content analysis and the writings in the Swedish national curriculum (The Swedish National Agency for Education, 2019) and Swedish School Act (SFS 2010:800), the Swedish steering documents. The themes were investigated in relation to the Swedish steering documents. This made it possible to explore EIs possibilities and challenges to meet SEM students' needs in their learning process and to put it in relation to national learning targets and special support.

Results

In the two sections below the results are presented by answering the two research questions of the paper. In the first section, the focus is on how EI is used in relation to SEM, and the second section focuses on the possibilities and challenges of using EI in relation to SEM in a Swedish context.

Explicit instruction in mathematics in research

Answering the first RQ of this paper, "How is EI depicted in research in relation to SEM?", we have in the content analysis in step two identified four different themes. The first theme is how EI in mathematics can be defined as a *systematic instructional approach of pedagogical instructions in mathematics education* to promote students' conceptual understanding and procedural fluency (Doabler et al., 2018; Archer & Huges, 2011). This type of definition and usage of EI is often used in interventions in relation to SEM (e.g., Swanson et al., 2015; Kong & Orosco, 2016). The instruction is conducted by validated principles of instruction, focusing on mathematical notions and abilities the individual student needs to develop. Doabler (2018) describes that in general, EI concerns three overarching principles: (1) Instructional scaffolding; here the teacher presents the mathematical content and often a procedure. This procedure is often a model that the student can follow regarding the specific type of task. This type of guidance often uses multiple representations, and the tasks are carefully selected. "Because instructional scaffolding is intended to be temporary, the support is gradually withdrawn as students become more independent in their mathematical learning." (Doabler, et al., 2018 p. 98) (2) Student practice opportunities; here the student gets time to engage and work with the content presented and guided by the teacher in step 1. In this step, the focus is to create opportunities for the SEM student to display and explore his or her thinking. This is done through discussions and visual representations of the current mathematical content worked with. The teacher must be active and give academic feedback to support the development of mathematical proficiency. (3) Judicious review; here the focus is to take time to go back and review the concepts and procedures worked with. This is made consciously and frequently. Well-designed reviews over time open opportunities for SEM students to build knowledge with critical topics in mathematics (Doabler et al., 2018).

The second identified theme is *word problems*, which is a reoccurring object of study when investigating EI in relation to SEM (e.g., Kong & Orosco, 2016; Hord & Xin, 2013; Swanson, et al., 2013; 2015). The reason for this might be that word problems contain several steps and procedural skills, as well as reading and language skills, which often is a problem for SEM students (Powell et al., 2010). A way to go about these problems is to implement EI, with specific instructions in relation

to word problems (e.g., Morin et al., 2017; Swanson et al., 2013; 2015). These studies show enhanced learning for students when teachers use EI. Although, important to point out from these studies is that EI in relation to word problems demands didactical teacher knowledge, as well as teacher knowledge about the individual learning needs of the students, to really be able to be explicit in the mathematical instructions (Kong & Orosco, 2016). Furthermore, it demands of the teacher to be able to identify different types of word problems and be able to sequence them over time to help students with structures (Powell, et al., 2010).

A third theme emerging in the analysis of studies with EI is the importance of different *mathematical representations* and helping the students to translate between representations (e.g., Kong & Orosco, 2016; Morin et al., 2017). The purpose of using representations is to help SEM students to develop conceptual knowledge in mathematics and eventually be able to translate between representations themselves (Acar, 2012). The purpose is also to help SEM students to see a connection between the conceptual and abstract strands of mathematics (Kong & Orosco, 2016). It is suggested that by using mathematical representations in the form of, for example, place value blocks in the EI students will be helped to grasp general understandings of a concept, for example, subtraction (Kong & Orosco, 2016).

The fourth and last theme identified is *working memory*. Working memory can be explained as concurrent storage and manipulation of information necessary to perform mental tasks (Acar, 2012). An argument made in research for using EI with SEM students is that the structure and explicitness of EI relieve the working memory, which has been identified as a weakness for many SEM-students (e.g., Swanson et al., 2013; 2015). Also, it is suggested that visual strategies rather than verbal strategies were more forceful in supporting SEM-students with low working memory doing problem-solving. (Swanson et al., 2015). Swanson et al. (2015, p.355) argue that “to be effective, instruction should be designed in alignment with the learners’ cognitive architecture” indicating the importance for the teacher to know their students.

EI and learning mathematics for SEM students

Answering the second RQ, “What are the challenges of using EI in relation to meet SEM students’ need in the Swedish school system?”, we elaborate on the possibilities and challenges to meet SEM students’ needs by relating the themes identified in research on EI to the Swedish context.

The way EI is thought upon in research, as a systematic instructional approach of pedagogical instructions in mathematics education, does not intervene with the Swedish steering documents negatively. If looking at the abilities in the Swedish curriculum it is stated that the education “shall give the students opportunities to develop” (The Swedish National Agency for Education, 2019, p. 56) their ability in mathematics. EI can contribute to that development for every student by providing a distinct structure in relation to the curriculum goals. Though, for EI to be able to contribute to the teaching of mathematics, teachers need to be able to connect the abilities written in the curriculum to EI and the systematical instructional approach of pedagogical actions. This to put the abilities into action in terms of EI. This is the first challenge of EI since it is not explicitly written in the curriculum how to teach so that the students develop the five abilities. The second challenge is that EI demands time, both time for the teachers to plan the EI, but also time for the students to go through the three

steps of EI (Instructional scaffolding, student practice opportunities, judicious review). This could be challenging to frame within the hours of mathematics education regulated by the Swedish School act (SFS 2010:800). Another challenge is the competence of the mathematics teachers, which in primary school often are general teachers. They need to be able to plan the instructional scaffolding and carefully choose tasks in relation to the mathematical concept or the procedure to be learned. Also, they need to be able to support with feedback and give students time to think and have time to work through the steps of EI. This is connected to yet another challenge factor for meeting the SEM students' needs, the knowledge and competence of teachers and school organizations regarding SEM, and multiple representations to support learning (Roos & Gadler, 2018).

Implications

This section discusses the implications of the findings in this paper.

The specific knowledge of SEM, and knowledge of how to support learning with for instance representations is needed to be able to pay attention to every students' knowledge, prerequisites, and needs. This knowledge is needed both in school organizations and for individual teachers. If there is a lack of this knowledge, there is a potential risk for SEM students not getting the right support ending up with an education that can actually hinder learning. Here school organizations must create spaces for collaboration between the special teacher in mathematics and the regular mathematics teacher to be able to plan the EI according to the specific needs of the SEM students and the specific context. Finding these spaces to collaborate and plan for the education has been proven to be a challenge in Swedish schools (Roos, 2015). If these spaces for collaboration would be offered, there is a potential for opportunities for collaboration between teachers. This collaboration might bridge the identified gap between ideological functions of inclusion described in the Swedish curriculum and the Swedish school act about how to do inclusion in the education (Roos, 2021) and support SEM-students in an inclusive classroom. Also, since the Swedish mathematics curriculum does not in detail regulate the teaching and learning content, materials, or methods, how the EI is planned and executed is much up to the schools and teachers. This can be both a possibility and a challenge depending on the knowledge of the teachers involved and the knowledge residing in the school organization. Moreover, a challenge for the schools and teachers can be not to end up in a deficit construction of SEM students where EI is the only solution. Instead, as shown by Lambert (2018), EI can be seen as one way among others to promote mathematics learning for SEM-students. In doing so, it is core to be aware of and recognize the value of students' own strategies, knowledge, and potential to engage in mathematics using multiple strategies. As argued by Lambert (2018), this can be achieved by adopting a neurodiversity perspective, which allows for the understanding of disability as diversity than a deficit.

Important to recognize when talking about EI in relation to SEM is that there are not any shortcuts. Even though overarching principles are guiding the EI, you must take the specific context and the individual student(s) and the situation in which the EI is conducted into consideration when planning, carrying through, and evaluating these lessons with EI. Although EI may take time before, during, and after the lessons, this research shows that in a Swedish setting it has the potential to diminish difficulties and enhance learning in a way that fosters a safe and fruitful learning environment. EI also has the potential to stimulate sustainable learning for every student. Though, it is important to

find the appropriate explicit instructions in relation to the mathematical content being taught, appropriate tasks, and the students taking part in the education. Then, instead of taking time from the teacher searching for different methods and tasks and taking time from the students struggling to understand or remember procedures, EI can actually save time instead. Last, but not least, when connecting this teaching method to a neurodiversity perspective on disabilities, students' equity and inclusion is more likely to be fulfilled.

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