CONNECTIONS BETWEEN SITUATIONS AND CONNECTIONS OF CONTENT – A SUPPORT FOR RECOGNITION OF SIMILARITIES IN MATHEMATICS

Conexiones entre situaciones y conexiones de contenido – Un apoyo para el reconocimiento de similaridades en matemáticas

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Abstract

How to work inclusively and engage students in special educational needs in the mathematics is a difficult task. In this article, I discuss teachers' awareness of connections between different teaching and learning situations, and the awareness of connections of content in the teaching as one way of including students who are in special educational needs in mathematics (SEM-students) in the mathematics taught in school. The importance of considering situated knowledge in the teaching of mathematics is highlighted through the notions *prepare, immerse and repeat* along with an awareness of mathematical tasks and representations. If focusing on *how and what* to teach in mathematics, the teachers can help the students to *recognise similarities* in mathematics between different teaching and learning situations, and enhance the inclusion process in the mathematics education.

Keywords: Inclusion. Situated knowledge. Special educational needs in mathematics. Recognition of similarities.

Resumen

Cómo trabajar inclusivamente y comprometer a los estudiantes en necesidades educativas especiales en matemáticas es una tarea difícil. En este artículo, analizo la conciencia de los maestros sobre las conexiones entre las diferentes situaciones de enseñanza y aprendizaje, y la conciencia de las conexiones de contenidos en la enseñanza como una forma de incluir a los estudiantes que están en necesidades educativas especiales en matemáticas (SEM- Enseñado en la escuela. La importancia de considerar el conocimiento situado en la enseñanza de las matemáticas se destaca a través de las nociones de preparar, sumergir y repetir, junto con una conciencia de las tareas matemáticas y las representaciones. Si se enfoca en cómo y qué enseñar en matemáticas, los maestros pueden ayudar a los estudiantes a reconocer similitudes en matemáticas entre diferentes situaciones de enseñanza y aprendizaje y mejorar el proceso de inclusión en la educación matemática.

Palabras clave: Inclusión. Conocimiento situado. Necesidades educativas especiales en matemáticas. Reconocimiento de similitudes.

Introduction

When talking about knowledge in mathematics, there is an assumption that we talk about the same thing. Though, mathematical knowledge has different meanings in different contexts and cultures and it also changes over time. What is knowledge today might not be knowledge tomorrow, as Gorard and Smith (2004 p.207) states, “knowledge is not a static commodity”. Hence, knowledge can be interpreted as situated in time and culture (LERMAN, 1999). This implies that what is perceived as mathematical knowledge, and how to support the development of mathematical knowledge is highly dependent on the time and place. If drawing on Wenger (2004) mathematical knowledge is situated in the past and the present, and it is visible in the situation, in the acting. This way of interpreting knowledge in mathematics has great implications for the teaching of mathematics and brings focus to the problem of transfer, which Lerman (1999) highlights and discusses as a problematic issue. In mathematics education, there has been, and still is, an on-going debate about the assumption that students can easily apply the mathematics learnt in school to their daily life or vice versa, such as work or shopping. Scholars have problematized this assumption (e.g. LERMAN, 1999; NUNES, SCHLIEMANN; CARRAHER, 1993) and argue that this so-called transfer does not exist, or at least is not straightforward. Instead, they argue that the knowledge is situated in space, time and activity.

Then, if looking at knowledge as situated, an important question which is discussed among scholars appears, namely, how the mathematics education can support students to use the mathematics learnt in school in their daily life or vice versa. In this article, another aspect of mathematical knowledge in different situation is highlighted, namely moving between regular mathematics education and special education in mathematics. More specific, the research question is: How can the mathematics education support students to recognise and use their mathematical knowledge, moving between different situations even *within* a school context, such as moving between regular mathematics education and special education in mathematics? Hence, in this paper I intend to discuss situated learning and teaching *within* the school context for students in special educational needs in mathematics[1] (SEM-students) from a teacher perspective, as one aspect of inclusion in mathematics. This will be investigated by analysing teachers' talk about learning and teaching mathematics from a SEM perspective. The next section will further discuss the notion of special education in mathematics.

Special education in mathematics

According to a Swedish government proposal from the late 1980s, special education can be interpreted as "activities for students that fall outside the natural variability of diversity" (PROPOSITION 1988/89: 4 p.80). Natural variability is not easy to interpret, and depends on who is making the interpretation. Accordingly, it is a hard to define the notion of special education. If connecting mathematics to special education, the questions arising addresses variability and diversity of knowledge in mathematics. Thus, SEM is a relative concept depending on who is defining the natural diversity among students and an interpretation situated in culture and time. The interpretation and use of the term *special needs* itself "depend ultimately on value judgements about what is important or desirable in human life and not just on empirical fact" (WILSON, 2002, p.61). It is a question of who or what has the authority and power to make these judgements and state the norm.

SEM and what it means is often discussed in practice among teachers in school but unfortunately not as much among scholars. It is also a term that is hard to define and has different definitions depending on from what epistemological field it derives from (BAGGER; ROOS, 2015). When looking at research on SEM, the epistemological fields within this research are connected to a psychological-neurological, social or pedagogical discourse. The epistemology is visible in the use of the terms and definitions of SEM. Terms occurring among scholars are for example children with mathematics difficulties (GIFFORD; ROCKLIFFE, 2012), dyscalculia (KAUFMANN, 2008), SEM-student (MAGNE, 2006), and mathematics anxiety (HANNULA, 2012). If trying to categorise these different terms into the above described discourses, both dyscalculia and mathematics anxiety would be placed in the psychological-neurological discourse while SEM-student and student with mathematics difficulties would be placed in the pedagogical discourse. Bagger and Roos (2015) suggest using the term students in special educational needs in mathematics, which is used in this paper. The reason for using this term is that the research derives from a relational and pedagogical perspective on mathematics diffi-

[1] The term special educational needs in mathematics, SEM, is a comprehensive term that has its origin in the British Warnock report from 1998 focusing on low achievement in mathematics (MAGNE, 2006).

culties, which focuses on teaching and learning activities and how they affect students' learning in mathematics. The student is *in* SEM because it signals that it is not a deficiency within the student, it is something the student can get in and out of (BAGGER; ROOS, 2015; ROOS, 2015). In this study SEM is seen upon as a need situated in a learning situation in mathematics, hence epistemologically this study derives from the (special) pedagogical discourse.

Theoretical framing

Two theoretical perspectives are used in this research, a participatory and an inclusive perspective. These perspectives were used to identify how participation in the mathematics education was talked about. To be able to look at participation, Wengers (1998) social theory on learning was used. Wenger's (1998) social theory is used in many different ways in mathematics educational research (PALMÉR; ROOS, 2016). In this particular research, only the part called communities of practice was used. Communities of practice focus on human participation in social practices. A practice exists because of people's engagement in actions and the negotiation of meaning of those actions between one another. The practices reside in a community of individuals with *mutual engagement,* meaning the members of the community are engaged, but the engagement does not need to be homogeneous, since diversity, disagreements and tensions can create productive relationships. Members of a community of practice develop a *shared repertoire*, such as experiences, tools, artefacts, stories, concepts and so on. This shared repertoire develops over time. The *joint enterprise* is a negotiation that keeps the community of practice together; the members are connected by their negotiation of a joint enterprise. The joint enterprise is a process that pushes the community of practice forward, as well as controls it. Hence, it is a collective process of negotiation of the members in the process of pursuing it (WENGER, 1998).

An inclusive perspective was also used in the investigation, specifically the notions *spatial, social* and *didactical* inclusion by Asp-Onsjö (2006). Spatial inclusion basically refers to how much time a student is spending in the same room as his or her classmates. The social dimension of inclusion concerns the way in which students are participating in the social, interactive play. Didactical inclusion refers to the way in which the students engage in the teaching, with the teaching material, the explanations and the content that the teachers may supply for supporting the student's learning.

The three terms spatial, social and didactical inclusion are used together with communities of practice as an overall frame in developing an explanatory framework. This particular framework seeks to increase our understanding of how students in SEM participate, develop their way of participating or are constrained in the participation in the school mathematical practice.

Since the awareness of the content and the connections in the teaching to be able to help SEM-students is foregrounded in this paper, the data analysed in this paper steams from the part of the framework that focus communities of practice in relation to didactical inclusion, although spatial and social is also considered in the analysis.

Methodological framing

In this research ethnography has been used as a methodological guide following a process of teaching SEM-students at a primary school in Sweden. The basis of ethnographic research is social interaction (ASPERS, 2007) and the researcher uses interpersonal methods. Sarangi and Roberts (1999) emphasize that institutional workplaces are social and to be able to understand them we need to use "thick descriptions" as a scope to reach from the level of fine-grained analysis to a broader ethnographic description. Thick descriptions can be described as holistic descriptions that "attends to the smallness of things and aims to understand them in all their interpretive complexity" (SARANGI; ROBERTS, 1999, p.1). Using ethnography as a guide in this project gave me as a researcher a way to explain the data construction and important issues in the data analysis in terms of what I did at the school and how I interpreted the data and made the (thick) descriptions. Ethnography also enabled me to highlight ethical issues, such as researching with a teacher and on students in SEM.

In this study a teacher in mathematics with great experience of teaching mathematics to SEM-students was followed during two years, a choice made in order to get "a best-case scenario". Patton (2002) describes this as an information-rich case for study in depth. Using Flyvbjerg (2006) one can say that this selection is information oriented and the case is an extreme one. An extreme case is a case to "obtain information on unusual cases which can be especially problematic or especially good in a more closely defined sense" (FLYVBJERG, 2006, p.230). In this investigation, the extreme case is used to obtain information about teaching of SEM and this case is expected to be an especially good case. The information-rich case here is Barbara. She is a 61-year old (at the start of the study) teacher in mathematics primarily working with students in SEM. Barbara has a degree as a lower primary teacher and worked as such for 26 years before becoming a special pedagogue[2], which she has been working for 6 years (at the start of the study). She has a special interest in SEM and been working with SEM for over a decade. The school Barbara works at is a large primary school with 6-year-old students up to 12-year-old student located in the south of Sweden. Over 40 teachers work at the school and they are divided into several teams, consisting of preschool teachers, leisure time teachers and primary school teachers. The students at the school come from both rural and suburban areas.

The data was constructed by using interviews and observations. Both the interviews and the observations were audio recorded with an iPad. The data construction was made during a two-year period. The focus in the analysis has been the interviews and the observations have served as a way of understanding the interviews. Accordingly, the observations have been used as contextualisation of the content in the interviews. These two data constructs have been used in a dynamic process in the analysis, working back and forth in iteration, in a process called static-dynamic analysis. In this type of analysis, the researcher codes the data and uses a code-scheme developed by theory and the constructed data (ASPERS, 2007). To conclude, the data constructed in this study consists of interviews and observations and is generated over time – meaning the analysis also has been made over time and the amount of data as well as the time have been important factors in the analysis.

Results and analysis

Below, two results are presented. The first concerns the identified communities of practice at the site. The second result refers to interesting issues appearing within the category didactical inclusion. These issues concerned the mathematics teaching and learning in different situations and connections between different situations. Over time, and on several occasions, these issues regarding the teaching of mathematics to the SEM-student in order to include them in the mathematics were discussed. Hence, these issues have been recognised and categorised with the help of the existing communities of practice at the school and didactical inclusion.

Communities of practice at the site

Four communities of practice were identified at the investigated school: community of mathematics classrooms, community of special education needs in mathematics, community of mathematics at Oakdale primary school and community of student health. In this article two of the communities is in focus, community of mathematics classrooms and community of special education needs in mathematics. The *community of mathematics classrooms* was created in mathematics classrooms at the investigated school and thus consist of several different visible communities of practice. Although there were several small communities of practice, the talk in these communities of practice can be interpreted within one larger community consisting of all the different communities of practice. The mathematics teachers at the school are members of the community of mathematics classrooms.

The mutual engagement of the teachers in these communities of practice was the mathematics learning for all students, that they worked according to the curriculum and all students reach the accepted level of knowledge. Even if there are several mathematics classrooms, the actual work with the students regarding mathematics and how to reach them in the classroom(s) is a shared repertoire. Barbara, a peripheral member in this

[2] Special pedagogue is a further education of 90 credits in Sweden.

community of practice in her role as a remedial teacher, wishes to have more influence; she wanted to be "open about our roles in the classroom" and "that we discuss together, what I can do".

The *community of special education needs in mathematics* is identified by the fact that SEM exists and is dealt with at the school. Barbara is a core member, since she is the only remedial teacher in mathematics at the school: "I serve from the first grade to the sixth grade". She points out "I have been interested in mathematics and the others remedial teachers at the school are not". She wants to develop the teaching of mathematics for all students at the school, because it is "very easy to see the problem within the student instead of what it is in the teaching that does not benefit all students".

The practices overlap and influence each other; hence, there is a constellation with interconnections. One overlap between the community of mathematics classrooms and the community of special education needs in mathematics is a shared goal of being able to develop mathematics education and enhance learning in mathematics for all students. These communities of practice also share members: the principal, Barbara and the mathematics teachers. Both the community of mathematics classrooms and the community of special education needs in mathematics have a goal of being able to enhance SEM-students to learn mathematics; hence this goal is an interconnection between these communities. The two communities both have the mathematics teachers and Barbara as in common members. Even though there are many similarities between these communities of practice, there are differences in core members, members, mutual engagement and shared repertories.

Connection between situations

Within the category didactical inclusion an issue discussed by Barbara and the researcher is the issue of situated knowledge and how Barbara can see this in the students' expressions. "You know this thing with subtraction, they [SEM-students] had told Jonna [the math teacher] that they had never worked with … They knew nothing about it … Well ... You know it was 14-6; it was a task that [the students] did not connect to this we've been working on a lot, within this very range of numbers." Barbara continues reflecting on this by saying "Then the question arises, is this, which we have practiced so extensively here, are they [the SEM-students] able to see that they have a use for this in [the mathematics] class?"

This issue of lack of connection between situations and the issue of situated knowledge can also be seen in Barbara's reflection of mathematics teaching to SEM-students. In the following sequence Barbara, together with the researcher, is reflecting upon how the knowledge seems to be bound to the situation for some SEM-students she is teaching and that the work with different representations seems to be a way to help do connections between situations.

B: No … what is it that makes …yes …
R: Thus, they can do it here [in the small group] but when they are in the classroom they don´t take the knowledge with them… it feels like.
B: No … is it like that? [...]
R: Is it bound to the situation?
B: Yes. Here they can do it! I thought, I must not forget that, you know, these steps [concrete, picture, abstract representations], concrete, it is there, but then sometimes in the representation phase you might draw [a picture] and then you are here [pointing on a place she marked as the third step, as abstract representations].
R: In the abstract
B: You have to remember that; you have to have that [the concrete representation] because I know I've made the mistake before and thought that it's enough to be there [in the picture].

Thus, as Barbara sees it, an important aspect for helping the SEM-students to make the connection between situations is to work with concrete, pictures and abstract representations parallel and not just stop with a picture and the concrete situation, but to also work with concrete representations. If doing so the SEM-students might be able to make connections between the different teaching situations in the communities of mathematics classroom and the community of special educational needs in mathematics.

Connection of content

Another interesting issue discussed in the category didactical inclusion by Barbara regarding the teaching of mathematics to the SEM-student, is how to make connections in the teaching of the mathematical content between different situations. The data shows three different ways in the teaching to make these connections and try to help the students *recognise similarities* between different situations in the mathematics education. These different ways are all *connections of the content* between the community of special education in mathematics and the community of mathematics classrooms.

The first way is *preparing* the SEM-students for upcoming mathematical tasks and content in the classroom by working with it with the remedial teacher in advance. Barbara talks about this at several different occasions:

It is important that I as a special pedagogue am informed. It is my obligation to find out to be able to link and prepare here [in the small group with the remedial teacher] to enable them [the SEM-students] to be proficient there [in the classroom] once they attend.

> [...] we talk about in advance to enable them to be a bit more involved and once Gabriel [a SEM-student] said; "Isn´t it cheating, what we 're doing now?" No, but there is little that we talk about things before, to be able to understand.

> On Tuesdays they are in the math [classroom], when it's Kangaroo math[3] and it's been great. We've had time; sometimes I have had time to prepare them a little bit so they have little [pre] understanding. They have been active [in the classroom].

Here Barbara talks about how to enable the SEM-students through preparation, so that they recognise similarities from tasks they worked with in the community of special education in mathematics and recall it in the community of mathematics classrooms to be proficient.

The second way is working on the same mathematical issues as in the classroom at the same time, using more concrete representations and basic tasks in order to *immerse* the knowledge in mathematics. Barbara says: "Jonna [a mathematics teacher] and I help each other to look at what you can work with when they're not in here [in a small group with Barbara] when we are working concretely". Barbara also points out that "it is about how we improve our cooperation, […] then they [the SEM-students] will get a feeling it's the same stuff we're working on".

Hence, Barbara is talking about how to immerse the knowledge in the community of special education in mathematics by using more concrete representations so that the students can grasp the content in the community of mathematics classrooms. Here Barbara highlights the necessity of cooperation between the regular mathematics teacher and her as a special pedagogue.

The third way is working with mathematical content that the students have not grasped after they have worked with it in the classroom, *repeating* it, one example is when Barbara says: "[...] to be able to capture and repeat what they do in the group". In this situation, even though the students have worked with the mathematical content substantially, they have to repeat it. Here it seems that the community of mathematics classrooms is steering the content in the community of special education in mathematics.

These three ways of trying to make *connections of the content* (preparing, immerse and repeat) can be seen as ways of supporting the transition between these two communities in order to highlight the mathematical content and to enhance recognition of similarities in the content for the SEM-students. Consequently, the connection between the content in the teaching in special education in mathematics and in the classroom is an issue for Barbara. To be able make this connection, Barbara talked about cooperation with the mathematics teacher. She thinks it is of great importance for the students learning in mathematics. "But it is important nonetheless, we [the teachers] have discussed how to get our act together, what we are going to work with, so that they [the SEM-students] are more likely to

[3] The Kangaroo competition is a yearly international problem-solving competition with five levels from preschool class to high school. The tasks from previous years are available and used in the mathematics teaching.

be involved in the discussions, that they feel a secure." Barbara wants to cooperate with all the mathematics teachers and even though she is a member in the communities of mathematics classroom, the data indicates it is not always possible to have this cooperation even though cooperation is a shared repertoire: "I have almost all teachers at the school [that she serves]; I would like to have it [cooperation] with all". She also reflects on the organisation of her duty: "[…] If I'm going to work with everybody like I am now, and then it's an obstacle. Because then it's ... Yes, there will be 18 classes here".

Hence, Barbara emphasised that to be able to do the connection of content in the teaching she needs to know what is done in the classroom even though she works with the SEM-student in a small group; she needs to be a broker between the communities of mathematics classroom and the community of special educational needs in mathematics. Although, there are obstacles for doing the brokering since the organisation do not support it.

Discussion

As shown in the result, connection between situations and connection of content seems to be important issues for Barbara when teaching SEM-students. If looking at connections between situations in this data, there is a lack of connections between situations for the students in mathematics, and one way of bridging between different situations and making connections is teaching with focus on representations and tasks. In this study, this seems to be of importance when talking about teaching mathematics with focus on SEM. The teaching in mathematics need to make the students aware of, and able to handle, different representations in different situations and the teacher needs to have knowledge of the use of different representations in relation to a mathematical content. Consequently, representations and tasks need to be considered as a part of the teaching and learning of SEM-students to enable them to make connection between situations.

When talking about connection of content from a situated perspective, three aspects of working with SEM were visible in the data, *prepare, immerse and repeat.* These aspects I call *content flow*, since they work as a way of trying to get the connection of content to flow between the communities of practice. All three can be applied, but depending on the student(s), the mathematical content and the situation, only one or two aspect(s) could be applied. Hence, the content flow is used in the teaching of mathematics between the community of special education needs in mathematics and of mathematics classrooms. This is a way of trying to get the SEM-student included in the mathematics (content) taught.

To strengthen the content flow, the teachers involved in the mathematics education need to be aware of different ways of supporting the SEM-students. Even more important, they need to be aware of *how* the mathematical content is worked with in different teaching situations. For instance, the teachers need to know which tasks are used, which representations are used, and whether the same representations could be used in the different teaching situations to enhance the students' recognition of similarities. They need to know whether the support of the recognition of representations in different semiotic systems[4] could be enhanced. If this were done at the investigated school, there might be a closer interconnection between the community of special education needs in mathematics and the community of mathematics classroom. The SEM-students can even contribute themselves to the content flow by suggesting content, tasks and asking questions based on the content in the mathematics taught in the classroom. This is also a way of helping students recognise similarities of content in different situations and encourage the students' to participation and inclusion in mathematics.

One conclusion drawn from this research is that there are different levels in the teaching of mathematics that need to be considered when focusing on inclusion of SEM students: the content level, which representations and tasks are suitable depending on the content, and the student level, which representations and tasks are suitable for this student in this particular situation. These levels need to be discussed by mathematics teachers involved in different teaching situations.

[4] A semiotic system is a system with signs for meaning making (WINSLØW, 2004).

Hence, if looking at mathematics teaching and learning from a social perspective teachers cannot assume that the SEM-students recognise the similarities we want them to do in the different teaching situations in mathematics, there is a need to support the recognition of similarities between different teaching situations in order to get the students to make the connections and achieve learning situations.

However, it is important to take into consideration that the epistemological stance of the teachers involved affects the work with the content flow. If the teachers do not think that the SEM-student should be in the classroom and that the mathematics in the classroom does not concern the SEM-student, it is difficult to discuss and use of content flow. An example of this was visible in the data, where a mathematics teacher says, "they [the SEM-students] hadn't learned much by being in here [the classroom]. I could not put the math level on their level".

Implications for practice

To strengthen the teaching and learning of mathematics, the teachers involved in mathematics education need to be aware of different ways of supporting the SEM-students and need to discuss these issues frequently. Even more important, they need to be aware of *how* the mathematical content is taught within different teaching situations to be able to help the students to recognise similarities with the help of, for instance, representations and tasks. The different levels in the teaching of mathematics in different teaching situations need to be considered and discussed, both the content level (which representations and tasks are suitable depending on the content) and the student level (which representations and tasks are suitable for this particular student in this particular situation). The teachers cannot assume that the SEM-students recognise the similarities in different situations. Hence, there is a need in the teaching of mathematics to support the students to recognise the similarities in order to achieve learning situations. All this implies that teaching mathematics is a complex process that involves awareness of individual students, knowledge of representations and the use of representations in relation to a specific mathematical content and cooperation between teachers. If focusing on how and what to teach in mathematics, the teachers can help the students to identify similarities in mathematics between different teaching situations. Obviously, this way of looking upon teaching in mathematics would certainly benefit all students, but, as it seems in this study, it is utterly necessary for the SEM-students.

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