INCLUSIVE MATHEMATICS FROM A SPECIAL EDUCATION PERSPECTIVE – HOW CAN IT BE INTERPRETED?

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The aim of this paper is to present a way of understanding the phenomenon of inclusion in mathematics. The theoretical framework consists of the connection between two theoretical perspectives and is tested in an empirical example of inclusive mathematics from the perspective of special education. The theory of communities of practice is used as an overall theoretical perspective along with a theoretical framework regarding inclusion. Sub codes were extracted from the empirical example to create a more fine-grained conceptual framework. The results show that the conceptual structure is beneficial for extracting a fine-grained conceptual tool in understanding and developing inclusion in mathematics.

Keywords: connecting theories, framework, inclusive mathematics, special education

INTRODUCTION

This paper discusses the connection of the theoretical perspectives in a research project focusing on the development of inclusive mathematics education, based on special education needs in mathematics. The connection is tested in an empirical example for understanding inclusion in mathematics from a pedagogic perspective.

The pedagogues that usually are involved in the situation of teaching students in special needs in mathematics are the mathematics teacher and the remedial teacher. The remedial teacher in mathematics needs to interpret the students' knowledge to be able to ensure that students' needs are met at all levels. On an overall epistemological level this can be made from a categorical perspective or from a relational perspective (Sjöberg, 2006). From a categorical perspective the problem is situated within the student. In contrast, the relational perspective investigates the environment surrounding the student and the influence it has regarding students' knowledge (Emanuelsson, Persson, & Rosenqvist, 2001). A relational perspective on mathematics difficulties stresses the need to consider how the teaching and learning activities in question affect the students' learning in mathematics (Dalvang & Lunde, 2006). The present project adheres to the relational view in striving to reach an understanding of inclusive mathematics. Specifically an inclusive perspective on mathematics education is adopted. In an inclusive perspective, knowledge and mathematical understanding are viewed as cultural and social phenomenon.

Research (e.g., Ballard, 1999) regarding inclusion is a major field of research, which mainly looks at inclusion from the pedagogical perspective. However, little attention has been paid to the meaning of inclusion in mathematics and the identification of barriers or factors that appear critical in the students' learning. Moreover, there is still

much to learn regarding how different factors work and connect in the pursuing of an inclusive teaching of students in special needs in mathematics. On account of that, the present paper aims at discussing the connection of theories in the overall conceptual framework trying to frame inclusion in mathematics from a special education view with the perspective of pedagogues. The perspective is also inclusive, where inclusion is seen as a social process of participation in the mathematical practice. This requires identification of both the students' participation and the communities they have access to. To capture and put words what is offered by communities of practice and the students' participation, a conceptual framework is needed.

Eisenhart (1991) recognise three types of frameworks (theoretical, practical and conceptual). Since this framework is built from different sources, it is a conceptual framework.

THEORETICAL PERSPECTIVES

In the overall study two theoretical perspectives are used, a participatory perspective and an inclusive perspective. These two perspectives are used to capture the research question of the study, namely: How is it possible to develop inclusive mathematics education, based on special education needs in mathematics?

Conceptualizing inclusion

The concept of inclusion is complex and difficult to define (Brantlinger, 1997). Nonetheless, it is a well-used term in schools today, even in mathematics education. Historically, inclusion is a relatively new concept. It was first used during the early 1990s, before that, the term integration was used (Farrell, 2004). Then what is the difference between these two concepts from a school context perspective?

The concept of integration was developed towards the end of the 1960s, as a critique to the various institutions created for deviant groups in society. Within a school context this term was used to emphasize an assimilation process, children with special needs would be fitted into an existing school context (Nilholm, 2006). In the 1990s it was perceived that the concept of integration did not fully covered the importance of participation and the term inclusion began to become more common (Rosenqvist, 2003).

The concept inclusion views "that the school (the whole) will be organized based on the fact that children are different (the parts)" (Nilholm, 2006 p.14, own translation). The concept of inclusion refers to a continuous process (Asp-Onsjö, 2006) in schools. The introduction of the concept inclusion had an intention, a wish to change the perception regarding work with students in special needs (Nilholm, 2006).

As previously mentioned, this project aims at investigating inclusion in mathematics from a participatory perspective. From this perspective inclusion does not just mean being in the classroom physically, it means to be included in the mathematical practice of the classroom, which can be anywhere, this form of inclusion has no physical condition, it is imaginary. Asp-Onsjö (2006) talks about *spatial*, *social* and

didactical inclusion. 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 inclusions concerns the way in which students are participating in the social, interactive play with the others. Didactical inclusion refers to the ways in which student's participation relates to a teacher's teaching approach and the way in which the students engage with the teaching material, the explanations and the content that the teachers may supply for supporting the student's learning. In this study the content of learning is number sense, since it is the content covered in teaching observed. These three analytical categories will be used as an overall frame in developing a fine-grained explanatory framework. This framework aims at increasing our understanding of how students with special needs in mathematics are participating, develop their way of participating or become restricted from participating in the school mathematical practice.

Students in special education needs in mathematics in communities of practice

This investigation of inclusion in mathematics education is grounded in a social perspective on learning. The overall principle of this perspective is that learning is considered to be a function of participation (Wenger, 1998). Participation is to be seen as "a process of taking part and also to the relations with others that reflect this process" (Wenger, 1998, p. 55). Participation is an active process that involves the whole person and combines "doing, talking, thinking, feeling and belonging" (Wenger, 1998, p. 56). It "goes beyond direct engagement in specific activities with specific people" (Wenger, 1998, p. 57). The practice "exists because people are engaged in actions whose meanings they negotiate with one another" (Wenger, 1998, p. 73) and the practice resides in a community of individuals with *mutual engagement.* Members of a community of practice are practitioners who develop a *shared repertoire,* such as experiences, tools, artefacts, stories, concepts etc., the *joint enterprise* keeps the community of practice together. It is a collective process of negotiation and the participants in the process of pursuing it define it.

As previously mentioned, I will investigate inclusion from a pedagogic perspective. In terms of participation this means that I look at how the teacher and the remedial teacher in mathematics allocate the problem of including students with special needs in mathematics to the mathematical practice. The prior presented learning theory that focuses on communities of practice (Wenger, 1998) is intended to be used. In this theory learning is seen as a process of social participation. The unit of analysis in this theory is the community of practice which is an informal community where people involved in the same social setting form the practice (Wenger, 1998). Although the social setting is important regarding special education needs in mathematics, the students´ conceptual understanding also has to be taken into consideration. In order to capture the students´ conceptual understanding, I will follow Graven and Lermans (2003) interpretation of Wenger (1998). The reason for this choice is that they argue that the primary unit of analysis in Wenger´s theory is communities of practice, but for teacher learning it permits the primary unit of analysis to be "the teacher-in-the-

learning-community-in-the teacher" (p.192). In the first phase of this project I will use Graven and Lermans (2003) unit of analysis, "the teacher-in-the-learning-community-in-the-teacher" (p.192). To reach the students (in the second phase of the project, right part of Figure 1) I will modify Graven and Lermans unit of analysis into "*the student-in-the-learning-community-in-the-student*". These units of analysis are coherent with Lermans (2000) unit of analysis from the social perspective, "person-in-practice-in-person" (p.38). This will give access to the individual in the community as well as the community of practice.

THE CONNECTION OF THEORIES

When connecting theories it is crucial to know how the connection is made and what it is in the theories that make them work together. According to Wedege (2010) the connection can take place at different levels of the theories. In this project a connection is made between the theory of communities of practice (Wenger, 1998) and the theoretical framework of inclusion (Asp-Onsjö, 2006) at the level of principles of the theories, since they both look at learning as a social phenomenon. Hence, the theories have compatible cores in their view of learning.

Although the complexity and size of the theoretical frameworks vary widely, they grasp the different aspects of the research question. Communities of practice are here seen as an overarching theory of learning. To this theory a connection is made to the three modes of inclusion that Asp-Onsjö (2006) presents.

Different strategies can be used connecting theories according to Prediger, Bikner-Ahsbahs, and Arzarello (2008). These strategies include having an understanding of different theories, to combine, coordinate or integrate them (Prediger et al., 2008). I coordinate communities of practice with inclusion, since they contain assumptions that are consistent. These assumptions are located in their social approach. The coordination creates a conceptual framework with well fitting elements that help in identifying both the students' and teachers' participation and the communities they have access to regarding learning in mathematics. The three modes of inclusion (Asp-Onsjö, 2006), which are deeply interconnected and constantly interacting with each other, puts words to and allows the development of a fine-grained framework regarding inclusion in mathematics. This framework may inform theory and therefore it has the potential to advance new contributions to the field through its explanatory power. The framework may also be able to contribute to the solution of the overall research question: How is it possible to develop inclusive mathematics education, based on special education needs in mathematics? This is done by identification of factors regarding inclusion in mathematics and their connection in the communities.

Normally concepts are defined and then operationalized. In this study the aim is to empirically investigate what inclusion in mathematics can be and how it can be developed by using necessary theoretical concepts. That is, what is and what is not inclusion in mathematics is an empirical question. In the overall study this is investigated through observations, group interviews and interviews with both

teachers and students. In this paper the pedagogue perspective is in focus. The data used to capture inclusion in mathematics from their perspective is interviews. To identify what inclusion in mathematics can be from the interviews, the conceptual framework will be used as an overall frame.

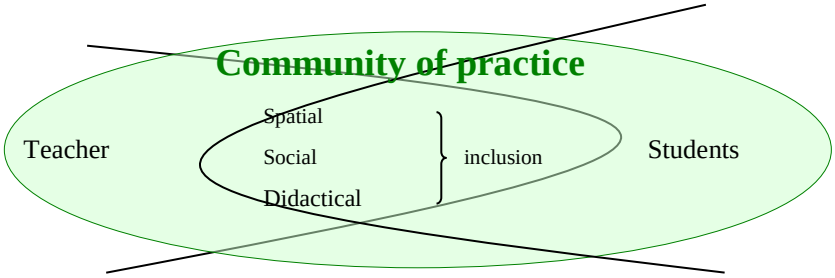

Figure 1. Representation of the concepts' interaction

Figure 1 presents community of practice as an overarching theory. The concepts spatial, social and didactical inclusion are interpreted within the communities and the focus inclusion concerns special education needs in mathematics. Here the meeting of the teacher and the student (the parabolas) is crucial for what kind/kinds of inclusion occur and what communities the students get access to. In this paper the left part of the figure is investigated.

METHOD

In the present project a large primary school, Oakdale School, located in a suburb of a medium-sized Swedish town is being observed. The on-going project is a longitudinal study with an ethnographic approach, which according to Aspers (2007) is a study where the researcher tries to understand a phenomenon through interpersonal methods. In this study the phenomenon of inclusion in mathematics is to be understood, hence the methods used are interpersonal. Interviews, discussions and lessons with teachers and the remedial teacher were observed and recorded during the first year of the project. 14 interviews, 24 observations at lessons and 3 group interviews were made. The construction of data is intended to continue for another year. In this article four interviews have been used in an empirical example.

The interviews are with Ellie, Anna and Barbara. Ellie and Anna are primary teachers working at Oakdale School. They both teach mathematics in lower primary school. Two of the interviews are with Barbara. She is a 60-year old remedial teacher in mathematics. Her current assignment for the last 2 years is as a remedial teacher with a focus on mathematics.

In the interviews a qualitative, semi structured approach was used (Kvale, 1996). The teachers were invited to elaborate on their view on students in special education needs and factors they consider crucial for students participation in the mathematical practice. The interviews were recorded and transcribed in full. The analysis was made using coding of the data by labelling the empirical material. This type of coding is the ground for creating new theoretical categories (Aspers, 2007). In the coding of the data, sub codes were identified. Using these sub codes a few major codes arose.

Subsequently, an analysis of how these major codes relate to the theoretical concepts was made. Using the concept of "communities of practice" (Wenger, 1998) the analysis started by trying to identify communities of mathematical practice from an inclusive perspective. By using the framework of Asp-Onsjö (2006) identifications of how pedagogues expressed their view of how to work with students in special education needs in mathematics referred to *spatial*, *social* and *didactical* factors were made. Digging deeper into the interviews, fine-grained codes regarding inclusion and communities of practice in mathematics were identified.

RESULTS

Communities of mathematical practice at Oakdale Primary School

Analysing the interviews, three communities of mathematical practice were constructed. The first practice is the *community of inclusive mathematics practice (CIMP),* which is created from the fact that the research project started at Oakdale School and the teachers are invited to collaborate in this project. Barbara is a core member in this community, since she is the remedial teacher in mathematics, and is eager to develop inclusion in mathematics at the school. 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]" (Barbara). Ellie and Anna are members of the community, since they are interested in developing their teaching of mathematics, and to "get more time to plan together" (Anna). The mutual engagement in this practice is the development of mathematics teaching for students in special education needs. Their shared repertoire is the talk about how to help the students understand, and their experiences of special education needs in mathematics.

The second practice visible in the data was the *community of mathematics classroom practice (CMCP).* This community is created in the classrooms and is thus two different communities of practice, one in Anna's classroom and another in Ellie's classroom. Ellie points out that it is important to "be involved" in the classroom activities, and Anna points out that it is "valuable that the students are present when the teacher presents the content". Barbara is a peripheral participant in these practices in her role as a remedial teacher and wishes to become more engaged, she wants to be "open about our roles in the class [room] "and "that we discuss together, what can I do". The mutual engagement in these practices is the mathematics learning for all students, that you work according the curriculum. The shared repertoire is the talk about the mathematics teaching overall, the curriculum and the use of different teaching materials.

The third identified practice was the *community of special education needs in mathematics (CSENM).* This practice is created by the fact that special education needs in mathematics exist at the school. It involves all mathematics teachers, though Barbara is a core member, since she is the only remedial teacher in mathematics at the school, "I shall serve from the first grade to the sixth grade". She points out that

“I have been interested [in mathematics] and the others [remedial teachers at the school] not”. Other remedial teachers in other nearby schools are part of this community, because Barbara points out that “we need to talk about how we do things […] talk about the subject and help each other”. In this practice the students in special education needs are participants. They participate and influence the teaching, since “You ask them: How do you want it to be?” (Barbara). The mutual engagement is the students in special education needs development of mathematical knowledge. The shared repertoire consists of the artefacts involved in the teaching, such as materials, games and tasks. It is also the individual education plans and their content.

All these three practices interrelate and influence each other, but there are differences of participants, mutual engagement and shared repertories in these practices that might influence the talk about inclusion.

Inclusion in the communities of practice

As mentioned earlier, in the screening of the data several sub codes regarding inclusion in mathematics were found. These were grouped into major codes and have been categorized into the three different communities of mathematical practice at Oakdale School. The three aspects of inclusion have also been taken into account in the categorisation. The role of mathematics is most visible within didactical inclusion, where the understanding of number sense becomes important. The codes in the matrix (Figure 2) are a fine-grained conceptual tool regarding inclusion in mathematics. Some of the codes occurred in more than one community of practice, but most of them only occurred in one of them.

Inclusion in the community of inclusive mathematics practice

In the community of inclusive mathematics practice (CIMP) all three aspects of inclusion were discussed. Within spatial inclusion the issue of being sensitive as a teacher regarding if the students in special education needs should be in the classroom or be in a small group with the remedial teacher were central to Barbara and Ellie. Ellie expressed that “they don’t have to go away somewhere else if they don’t like it”. Barbara pointed out that “some [of the students] don’t want to leave the class [room] so you have to think about how to help in the classroom”. Acceptance was an issue within social inclusion referring to a permissive climate in the practice. Barbara pointed out that “it is an upbringing issue, you may not laugh at anyone”. Barbara here connects “the knowledge process with the work with values”. Ellie also emphasised this, referring to the classroom practice in saying “we have different needs […], [we] have taught the kids to accept that we work differently, a permissive climate”. The category referring to didactical inclusion in this community was teaching approaches. All the three teachers referred to this with impact. It refers to how to work concretely with the students in special education needs. Anna talks about to “give everybody tasks that they can work with and understand” and Ellie says that one aspect of inclusion is to “give them questions that you know they will be able to answer”. She emphasises that “you [the teacher] need to be aware of that

you have the lesson at three different levels" referring to have several teaching approaches within the classroom. Here, Barbara points out "it is about how you ask the question" so that you include everybody.

Inclusion in the community of mathematics classroom practice

In the community of mathematics classroom practice spatial and didactical inclusion was visible. Within spatial inclusion Anna expressed that she is eager that all the students in the class attended the briefings in mathematics in the classroom. Ellie mentioned it, but was not so explicit. Looking at didactical inclusion, three codes emerged: individualisation within the classroom; teaching approaches; and mathematical knowledge. Regarding the first, this refers to being able to "individualise tasks within the class" (Barbara) and to "think about to come to them [the students in special education needs] often" (Ellie). Talking about teaching approaches in this practice is practically the same as presented above in Inclusion in the community of mathematics classroom practice. The difference is that the students are more visible and engaged in this practice, "they support each other" (Ellie). Mathematical knowledge is here to be seen as knowledge about the mathematical content the current teaching includes, how to present it and to make different approaches to the content more specific. The content discussed is number sense, within the number range 1-1000. A central question here is "what are we going to teach them and who is responsible?" (Barbara), referring to the mathematical content.

Inclusion in the community of special education needs in mathematics practice

In the community of special education needs in mathematics all three aspects of inclusion are visible. Terms for teaching are within spatial inclusion and deal with issues regarding organisational aspects such as access to study rooms nearby and time to collaborate and that two pedagogues will be in the class at the same time. Within social inclusion, Barbara emphasises students co-decision, "that you really ask, how do you want it?" that you [as a student] get to "be a part in the decisions". The didactical aspect of inclusion is mathematical knowledge, which refers to the mathematical knowledge of content the current teaching includes, as above. There is one distinction though, in this practice it is specifically how to deal with the knowledge that is difficult for students in special education needs; To be able to use different representations and have a "learning path that is truly systematic" (Barbara).

Inclusion / **Community**		**Spatial inclusion**	**Social inclusion**	**Didactical inclusion**
CIMP	Barbara	Teacher's sensitivity	Acceptance	Teaching approaches
	Ellie	Teacher's sensitivity	Acceptance	Teaching approaches
	Anna			Teaching approaches
CMCP	Barbara			Individualisation

				Teaching approaches
				Mathematical knowledge
	Ellie	Attend the briefings		Individualisation
				Teaching approaches
				Mathematical knowledge
	Anna	Attend the briefings		Teaching approaches
				Mathematical knowledge
CSENMP	Barbara	Terms for teaching	Student's co-decision	Mathematical knowledge
	Ellie	Terms for teaching		Mathematical knowledge
	Anna	Terms for teaching		Mathematical knowledge

Figure 2. Inclusion in the communities of practice at Oakdale School

The matrix in Figure 2 presents a summary of the analysis, with major codes of the teachers' expressions of how to work with students in special education needs.

CONCLUDING REMARKS

In this paper the connection of the theoretical perspectives in the current research project has been presented and tested in an empirical example for understanding development of inclusive mathematics education based on special education needs in mathematics. The overall framework has been shown beneficial for extracting a more fine-grained conceptual tool in understanding and developing inclusion in mathematics. The empirical material has been instrumental in the development of the conceptual tool, and in the connection of theories. This is visible in the extracted codes in figure 2, where the three identified practices have served as a filter to identify inclusion at different levels at Oakdale School from a pedagogic perspective. Within didactical inclusion teaching approaches, mathematical knowledge and individualisation emerged with different emphasis within the three practices. The practices interact and influence each other, but inclusion looks a little different in the practices and this might influence the understanding and development of inclusive mathematics at Oakdale School. The identified codes have the potential to be generalised and it may be possible to identify other codes analysing the material in its entirety.

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