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# What can five-, six- and seven-year-olds tell us about the transition from mathematics in kindergarten to that in school in Norway?

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*As we grow from small children to adults, we experience several transitions. This paper focuses on children's voices on the transition from mathematics in kindergarten to that in school. What are their thoughts on going from one institution to another with a different curriculum, culture and values regarding mathematical learning? This paper reports answers from focus group interviews with children, ages five, six and seven, about mathematical learning. The study was situated within a research and development project SUM at UiT The Arctic University of Norway. The findings show that even though the transition is clear for teachers, both in kindergarten and school, we need to discuss how to present mathematical activities to children such that these activities help to ease the transition from one level of education to another.*

*Keywords: Mathematics, kindergarten, transitions, school.*

## Introduction

The transition to school is one of many transitions that children experience during childhood, youth and adolescence. First, they undergo the transition from home to kindergarten. In Norway, we use the term kindergarten for institutions providing early childhood education and care for children from ages one to five years. Next, they experience the transition from kindergarten to school and therefore go from one institution to another, which have different curricula. Finally, the transition to higher education and/or work occurs.

This study was situated within a research and development project called SUM (Blomhøj, 2016) – the acronym for the Norwegian title of the project, *Sammenheng gjennom Undersøkende Matematikkundervisning*. SUM focus on five transitions in the educational system. These are Kindergarten => Primary school => Middle school => Lower secondary => Upper secondary => University. At all five transitions students typically experience a discontinuity in their mathematics teaching. For each transition, a group of teachers and researchers will design, test and evaluate inquiry based mathematical activities. One assumption in SUM is that inquiry based mathematics education (IBME) can help students to explore the transitions as more continuous and transparent. IBME can be seen as a way to motivate students to learn mathematics through investigation in and with mathematics (Artigue & Blomhøj, 2013). Consequently, it is necessary to listen to the students voices on both mathematical activities and how they explore the transitions.

This paper presents children's descriptions of mathematics and mathematical activities in kindergarten versus school, and their thoughts about the differences going from kindergarten to school. Do we as professional teachers take some aspect of the transition for granted? Accordingly, our research question was as follows: *What can children, ages five, six and seven, tell us about mathematics in kindergarten and in school and the transition between these institutions?*

## Theoretical background

Transitions have been recognised as a challenge for children. Einarsdóttir (2007) reports that children characterise preschool and first grade in similar ways. They expect a change from more free play in preschool to more academic work in primary school. According to Hogsnes and Moser (2014), kindergarten teachers and schoolteachers agree on the importance of children experiencing a connection in the transition to school and it being well-defined. However, Hogsnes and Moser also stress that the transition will have to represent some changes. The children also expect this distinction, as Einarsdóttir (2007) finds. Further, Hogsnes and Moser (2014) argue that one way of making the connection is to allow children to present in school something in which they were involved in kindergarten. Almost 70% of the kindergarten teachers in their study see this presentation as important, whereas 60% of the schoolteachers find it somewhat important or unimportant.

The Framework Plan for Kindergartens (Kunnskapsdepartementet, 2017) defines the content and tasks for kindergarten in Norway. The core values of kindergarten shall be “promulgated, practised and manifest in every aspect of a kindergartens pedagogical practices” (p. 7). This means that play and the children’s initiative are important parts of the curriculum. The framework is structured on the basis of learning areas instead of traditional subjects. For mathematics, the learning area is called *quantities, spaces and shapes* and is based on Bishop’s six mathematical activities. Regarding the transition, the Framework Plan states that “working in partnership with the parents, the kindergarten shall ensure that the child has a safe and good transition from kindergarten to school” (p. 33).

Bishop (1988) defines six universal mathematical activities – namely, *counting, locating, measuring, designing, playing* and *explaining*. For these six activities to provide a useful structure to help children experience a successful transition into formal mathematics, he argues that it is necessary to embed them in the value-laden frameworks of the classroom (Bishop, 2016). Bishop presents six value clusters, grouped into three sets of complementary pairs. The first pair is *ideology: rationalism and objectism*. Argument, reasoning, logical analysis and explanation are all aspects of *rationalism*. Encouraging students to search for different ways to symbolise and represent ideas falls under the value of *objectism*, as does appreciating and creating mathematical objects. The second pair is *sentiment: control and progress*. *Control* involves rules and prediction. Valuing control means emphasising not just the correct answer but also the checking of answers and explaining why other answers are not correct. *Progress* concerns how mathematical ideas grow and finding alternative and non-routine solutions. This value also contains individual liberty and creativity. The third and last pair is *sociology: openness and mystery*. Valuing *openness* means appreciating sharing and defending answers in class. A good practice is asking students to explain their ideas to the whole class. Valuing *mystery* means promoting thinking about the origin and nature of knowledge. This can be done by telling stories about old mathematical puzzles and searches for negative numbers and zero. Bishop (2016) concludes that values in preschool and school are not the same and we must be conscious of the differences.

In the curriculum for the common core school subject of mathematics (Kunnskapsdepartementet, 2013), the focus in years 1–4 is on numbers, geometry, measurements and statistics. After years 2 and 4, competency goals are formulated. Regarding the curricula for school and the Framework Plan for Kindergartens, there are some important differences to note. The most obvious difference is between the competency goals in school and more process-oriented goals in kindergarten. This also means that there are cultural and value differences between these Norwegian institutions. However, both plans emphasise the importance of explorative, playful, creative and problem-solving activities, which is also the aim for the SUM project.

Developing the IBME theoretical framework in order to address challenges in transitions is the focus in the SUM project (Blomhøj, 2016). The teachers and researchers jointly designed two inquiry based mathematical activities. Both activities followed the phases from inquiry-based mathematics education (Artigue & Blomhøj, 2013). However, since this was the first year of the SUM project, the emphasis was on phases one, *setting the scene*, and two, *students' investigative work*. The teachers in school and kindergarten tested the activities. The aim of the activities in SUM is to investigate if and how they can contribute to a transparent transition.

The first activity involved a tangram. The given introduction was the story about how Tan wanted to impress the emperor. Then the children had to conduct the investigative work of determining ways of putting the tangram into different figures. The progress differences from kindergarten to school were visible through the focus on visualisation in kindergarten and on properties and counting edges in school. The second activity involved word problems and early arithmetic. Here, the introduction was aimed at creating a story that could make room for word problems. The jointly developed story was about a bus, and the focus was passengers who got either on or off the bus at bus stops or stories from inside the bus. An example is as follows: “There are seven seats in the bus. Three are taken. How many are free?” One group of kindergarteners created a story about a human-like creature from Sami folklore, Stallo, who likes to eat people.

### **Data collection and analysis methods**

Data were collected using focus group interviews with eight groups from kindergarten and elementary school (Cohen, Morrison, & Manion, 2007). There were four groups from two different kindergartens (age 5), two groups from year 1 of school (age 6) and two groups from year 2 of school (age 7). In total, 13 children from kindergarten and 12 schoolchildren participated. We used convenient sampling for selecting the participating children. All interviewed children are participants in the SUM project. The argument for including also second graders (age 7) was that they in general have more developed language. The interviews were semi-structured and the questions were based on different aspects of mathematics from the SUM project. Each interview began with the same question: “What is mathematics (about)?” Subsequent questions concerned what they do when they do mathematics; whether we need mathematics (and for what); whether they find mathematics interesting; and how to be good at mathematics. Some questions differed for children in kindergarten and those in school. The kindergarteners were asked what they thought mathematics would be like in school. Conversely, the schoolchildren were asked what mathematics they had done in kindergarten. In addition, we brought tangrams to the kindergarten interviews to

help the children remember the activities from SUM. The schoolchildren were asked to show examples of mathematics on paper.

The interviews were video-recorded and transcribed to the written Norwegian standard bokmål, and then translated into English. NVivo 12 was used to analyse the data. For each question in the interview, we coded the answers and created categories. E.g. for the first question “What are mathematics about?” the categories were counting, calculating, numbers, shapes, measurement and others, like homework. The presented excerpts are to be seen as anchor examples of the categories.

Interviewing children can be challenging also due to which term to use. The term mathematics was challenging because the children did not seem to use the term themselves or have a full understanding of it. However, we clarified the term together with the children. We therefor used the term in the rest of the interview.

## **Results**

This section will present and discuss our findings from the interviews. The section is structured according to the interview questions.

### **What is mathematics about?**

When asked what mathematics is about, most of the kindergarteners were silent or said that they did not know. After some consideration, two children answered that mathematics is about counting and adding things together. Some children also answered making movies, reading and homework.

To move the interview along, the interviewer proposed that mathematics could be about doing arithmetic. In the curriculum in Norway the term calculate is used as a synonym for doing arithmetic. The children then said that they knew about calculation. John said, “Calculation is about doing homework”. However, what he meant by “calculation” was unclear, because he later said he added letters. Olivia said that she had heard about mathematics because her older sister was doing mathematics; however, she did not clarify what she meant by “doing mathematics”.

The picture gleaned from the schoolchildren’s interviews is more diverse. Some of the six-year-olds were not familiar with the term mathematics, but the most common answers were counting and calculating numbers, followed by shapes and measurements.

In terms of children’s understanding of mathematics, some differences between the children in kindergarten and the schoolchildren are evident. The children in kindergarten gave in addition examples of activities like making movies, reading and colouring. These are not typically mathematical activities but can include and give children experience with mathematics.

### **Do we need mathematics?**

When asked if we need mathematics, most kindergarteners and schoolchildren answered yes, but their answers differed somewhat. One group of kindergarteners said that there was no need for mathematics in kindergarten because they were so young. The following example is from an interview in a kindergarten:

John                    Because we then know what to do in school.

Interviewer Do we need mathematics outside of school?

John Maybe

Olivia Yes

Interviewer When do we need mathematics?

John Because we try to learn all the things we are going to do at school.

Interviewer What do you think, Olivia? When we are not at school, you said we need mathematics. When do we need it?

Olivia I do not know. I am not thinking about it. I am just thinking about butterflies.

John said, “Because we then know what to do in school”. Then the interviewer asked if we need mathematics outside of school. John did not really answer this question; instead, he returned to his original statement about knowing what to do at school. When Olivia was directly asked about mathematics outside of school, she replied, “I am just thinking about butterflies”. This may indicate a lack of interest in mathematics, at least in the interview situation.

The schoolchildren agreed with the kindergarteners that mathematics is not necessarily required in kindergarten. However, they gave more examples of situations where we need mathematics – namely, shopping, readiness for work and to carry out mathematical tasks. The following excerpt is from an interview with seven-year-olds.

Interviewer Why is it wise?

Lucy Because it is easier to go shopping

Kate and, if someone gives you a math task

Lucy It is wise to know.

Lucy argued that we need to know mathematics because it is wise to know in order to go shopping. According to the schoolchildren, this is the most common situation where we need mathematics. Kate’s statement, “and, if someone gives you a math task”, may indicate that mathematics is something you only need in school.

### **How to be good at mathematics**

In general, the kindergarteners and schoolchildren said that practising and working with mathematics can make you good at mathematics. They also considered homework as a significant factor.

Interviewer How can you be good at mathematics?

Lucy We have to practise and make mistakes

Kate Yes

Sarah You can learn from your mistakes

...

Interviewer In what way can you learn from others?

Lucy If you have an older brother or sister, you can learn mathematics.

Interviewer Can you learn from students in your class?

Lucy Yes

Lucy (age 7) started by stating that you need to practise, but also that you can learn from your mistakes. Sarah and Kate agreed with that statement. Learning from mistakes places the focus on finding one right answer, but also that a wrong answer can lead to an opportunity to learn. Instead of focusing on correct answers, the children in kindergarten were more focused on doing mathematics.

### **What do you do in kindergarten and how do you expect it will be in school?**

The kindergarteners said that the mathematics they were doing was mostly about counting, arithmetic and shapes. They also mentioned making movies and baking as mathematical activities.

In the interviews, we asked the children directly about the activities in SUM.

Interviewer Do you remember what you have been doing? Have you done *Formjakt* (an activity that entails looking for different shapes)?

Audrey No, we did the bus

Interviewer What was that about?

Audrey It was about counting.

“We did the bus” is a reference to the word problem activity in SUM. The children remembered the activity and clarified that it was about counting.

Audrey and we have put shapes together

Audrey and we remember the man who made a nice gift and...

Leah ... then he fell on the steps. And then...

Audrey ... we had to build it up again.

Audrey But it was just a story.

Audrey and Leah showed that they remembered the story about Tan. Even though their initial response was that they did not remember, without help from the interviewer they recalled important actions from the story. They also remembered that they had to put it all together. We can identify both the setting of the scene and investigative work components of the activity from SUM. In the last statement, Audrey clarified that overall, it was just a story.

In the kindergarten where the setting of the scene was about the Sami creature Stallo, we wanted to see if the children remembered the activity. They confirmed with “mm”, meaning yes.

Interviewer Maybe I could create a word problem

Sophie            I can make one. Once upon a time there were three bears sliding down a hill. And at the bottom of the hill, there was Stallo.

This is a clear reference to the activity. Sophie could recall the situation and was able to create the beginning of a word problem. The reason why she referred to bears instead of children is most likely that we had introduced counting bears in the interview. It is quite challenging to create a word problem on the fly and in an interview like this. We recognised this as a sign that they had remembered the activity and had gained experience from the first two phases. Regarding the children's expectations of what mathematics would entail in school, they emphasised learning about numbers and doing arithmetic.

### **What do you do in school and how is it compared to kindergarten?**

Concerning this question about mathematics in school, it became apparent that the schoolchildren could name more mathematical activities, including discussions and playing games. However, they still mostly brought up activities like calculating numbers, working with shapes and using textbooks or worksheets.

They did not remember much about their experience of mathematics during kindergarten. As Lucy said, "No, I think maybe in the last year. Sometimes, maybe once. We gathered to do worksheets – math worksheets – very easy tasks". Several children mentioned easy tasks in kindergarten as things they remembered. For example, Ryan (7 years old) said the following:

Interviewer    Do you find the mathematics in kindergarten simple?

Ryan            Yes

Interviewer    Do you find the mathematics in school hard?

Ryan            It was not so easy in kindergarten either, because we were much younger. Then it was the same as we have it now, in kindergarten.

First, he claimed that mathematics in kindergarten is easy. After the interviewer followed up this statement, he did not directly answer the question, but gave a reflection on learning.

### **Discussion and implications**

First, we wish to discuss the content of, and the need for, mathematics as children see it. Our data show that children in kindergarten, in general, are not familiar with the term mathematics. Sæbbe and Samuelsson (2017) offer a possible explanation: most kindergarten teachers avoid using the term mathematics when they engage children in mathematical activities. According to the kindergarten teachers, they are afraid that the activities could be regarded as boring and "schoolish".

In the curricula for both kindergarten and school, mathematics is about helping children understand the world. Although the aim is to prepare the children for developing a broader understanding of mathematics, our data show that the kindergarteners and schoolchildren had a narrow understanding of mathematics, viewing it mostly as being about doing something with numbers, shapes and counting. The schoolchildren, however, also talked about subjects in mathematics.



Significantly, according to Bishop (2016), the values in school and kindergarten are different. Lucy said that you can learn from your mistakes. This could indicate a focus on checking answers and knowing why an answer is not right, similar to Bishop's *control* value. At the same time, children in kindergarten have a strong focus on doing – hence, *progress*. This could be an indication of the distinction between the process aim in the kindergarten curriculum and the competence aim in the school curriculum.

When we asked about doing mathematical activities, the kindergarteners and schoolchildren gave more detailed examples. It is clear from our data that the children remembered activities from SUM, but did not necessarily see them as mathematical. This raises some new questions regarding the transition to school. Is mathematics a Trojan horse, as Fosse et al. (2018) claims? Does the term mathematics scaffold the transition or is it an obstacle? One way to investigate this further would be through projects like SUM. In SUM, the goal is to develop enquiry-based activities that follow the curricula and cultures of both kindergarten and school. Our data suggest that activities may be the missing link in order to make the transition more transparent. Our findings also imply a need for a discussion on how to present activities so that children have the opportunity to discover the mathematical ideas regardless of whether the term mathematics is used.

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