CHILDREN'S CONCEPTIONS ABOUT MATHEMATICS AND MATHEMATICS EDUCATION

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This paper deals with younger students' (grade 2 and 5) conceptions about mathematics and mathematics education. The questionnaire consisted of three parts: (1) statements with a Likert-scale; (2) open-end questions where the students could explain further their conceptions; and, (3) a request to draw a picture of yourself doing mathematics. The results from the statements were summarised and the pictures were analysed. Most students in grade 2 had a positive attitude towards mathematics whereas a larger proportion in grade 5 gave negative answers. All students presented mathematics as an individual activity with a focus on the textbook. The elder students narrow the activity down to calculating. A post- questionnaire confirmed the results.

INTRODUCTION

A body of research has pointed out the important role conceptions (here including attitudes and beliefs) linked to motivation and emotion play when doing mathematics (e.g. Hannula, 2006; Ryan & Deci, 2000; and, Schoenfeld, 1985; 1992). For instance, it has been highlighted that when someone finds a task meaningful there is a drive and a willingness to acquire knowledge. Students that show a positive intrinsic motivation are inspired, wanting and striving to learn (Ryan & Deci, 2000). The feeling of success or failure is important for the motivation and the relating conceptions. Hannula (2006) states that emotions are the most direct link to motivation. These are manifested either in positive or negative feelings depending if the situation is in line with the motivation. How you perceive an educational situation connected to your motivation and your emotions sets the arena for the individual learner.

In Sweden the motivation amongst pupils are relative high in the first grades, reaching its peak a grade 4-5, but with time the interest and motivation are decreased (Skolverket, 2003). The students' conceptions showed a negative development over the grades. The purpose of this paper is to investigate the difference in grade 2 students' conceptions about mathematics and mathematics education with students in grade 5. The reason for doing so is to see whether there is an explicit difference in their conceptions about mathematics and mathematics education and what this difference consists of. If so, this could work as adding information to the figures from the School agency (ibid.). Also, very little is known about younger students conceptions about mathematics and mathematics education.

First we have to define conceptions. Thompson (1992) describes conceptions as "conscious or subconscious beleifs, concepts, meanings, rules, mental images, and preferences" (p. 132). We follow this description and conception is here defined as an abstract or general idea that may have both affective and cognitive dimensions, inferred or derived from specific instances. Hence, students' conceptions consist of their belief systems, values, and attitudes reflecting their experiences. Here there is a special focus on conceptions about motivation.

METHOD

The research questions posed are: (1) What is mathematics according to students in grade 2 and grade 5?; (2) What is their motive to do mathematics?; and, (3) According to the students, how do they feel when they are doing mathematics? These questions will be answered by studying the pupils' answers to a questionnaire divided into three sections. The first section is quantitative part consisting of three statements with a Likert-scale in four steps. Each step is represented with a face with a different facial expression: very happy, happy, sad, and very sad. The statements are two statements about mathematics ('What do you think about math?' and 'When you have a math class, do you want to do math?') and a control statement about art class ('What do you think about art?'). The aim for this section is to give an indication of the pupils' attitudes towards mathematics. The second section is a quantitative part with three open-end questions: (1) 'Why do you do math?'; (2) 'How do you feel when you do math?'; and, (3) 'What do you do in a math class?'. The purpose of this section is to further clarify the pupils' attitudes towards mathematics with a special focus on what the children pick out as typical to do when you do mathematics. The third and last section is a qualitative part where the pupils are asked to draw a picture of themselves when they are doing mathematics. The purpose with this part is to get a broader insight into what the children think of themselves as a participator in mathematics education. A pilot study was made. The questionnaire was handed out to two classes, one grade 2 (19 students) and one grade 5-6 (11 students) in a public school in an average sized rural Swedish town, before a mathematics class. As a post-questionnaire, the same questionnaire was handed out just after the mathematics class. The purpose for this was to see the consistency in the students' responses. Here, the results from this pilot study will be analysed and presented.

The responses to the questionnaire were summarised and analysed. The responses to the quantitative part were condensed into two categories, positive attitude towards mathematics or negative attitude towards mathematics. The reasoning for doing this is because this part of the questionnaire works only as an indication of the conceptions. The responses to the open-end questions were gathered into different themes, looking for central descriptions the students use when talking about school mathematics and mathematics education. The reason for having a very limited number of statements and questions was to make sure that the younger students

would be able to follow through the questionnaire, but still allow comparisons with the older students.

The third part uses picture analysis. The chosen perspective is that through a picture, different messages can be communicated between the artist and the viewer just as in a verbal process (Borgesen & Ellingsen, 1994). Hannula (2007) points out that younger students may have difficulties to communicate their conceptions with written and oral media and therefore using pictures as a tool could provide additional information that the other research methods might not cover. The students were asked to draw a picture of themselves when doing mathematics. The purpose of the picture analysis is to separate different parts of the picture in order to get a better understanding of what the artist wants to communicate, consciously or unconsciously. This separation is done in three levels. The first level of the picture analysis is what you can see: (1) What does the picture portray?; (2) What objects are presented?; and, (3) How is the picture composed? The next level concerns the technique: (1) Which technique has been used?; (2) How are the pencil lines and the pressure of the pen?; (3) Is the picture harmonic?; (4) What is the chosen perspective?; and, (5) Is there any part of the picture that is particularly accentuated? The chosen perspective is important for how the artist feels about the message (Borgesen & Ellingsen, 1994). Once the picture has been broken down to these parts, the next level is to assemble it back to its whole again and instead of focusing on the details trying to understand the complete message from the artist: (1) What impression does the picture signal?; and. (2) What is the main thought described in the picture? The two pictures, one before and one after the mathematics session are compared. Technical knowledge could affect the students' pictures where the less skilled ones might be restrained in their ability to produce. However, with the three levels of analysis different aspects of the picture are analysed and technique is only one part of many in the analysis. In the final step, the results of the picture analysis are connected to the results from the quantitative and the qualitative parts of the questionnaire.

RESULTS

In this section the results from the pilot study is presented. We will first present the results from grade 2 and thereafter grade 5-6.

Grade 2

Because of the small number of respondents, at this stage no statistical analysis has been made. The data is therefore only presented as descriptive statistics with the purpose to show indications. The results from the post-questionnaire are in brackets.

Statement	Positive (*n*)	Negative (*n*)
What do you think about mathematics?	17 (16)	2 (3)
What do you think about art?	19 (17)	0 (2)
When you have a math class, do you want to do math?	16 (15)	3 (4)

Table 1: Results from quantitative part grade 2, *n*=number

From Table 1, we can see that most students are positive towards mathematics even in comparison to art class. When summarising the responses from the open-end questions there are a few themes that re-occur. To the question 'Why do you do math?', the following four answers were the most frequent ones: (1) Because it is fun; (2) To learn; (3) Because the teacher says that they have to; and, (4) To finish the textbook. The first two could be described as positive intrinsic motivation, whereas the last two have more of a negative extrinsic motivation attached to them. These replies are the most dominant ones in the post-questionnaire as well.

The next question was 'How do you feel when you do math?' and, following three themes were the most common ones: (1) happy; (2) focused; and, (3) it feels hard. The responses to this question are, just as to question 1, divided into one half that is negative and one half that is positive. When comparing with the post-questionnaire the consistency is high.

The third question was 'What do you do in a math class?', and the majority of the students replied 'work in the textbook'. Some of the other responses were 'raise my hand', 'go to the toilet', 'scribbling' and 'to chit-chat'. In the post-questionnaire, the most common reply is 'to work in the textbook'.

The results from the picture analysis showed that most students draw themselves alone, sitting down next to a bench working in a textbook. Some students added the blackboard as an illustrative component of what was in the textbook. The emotion signalled was mostly happy (described with a smiling face), sometimes combined with an element of feeling puzzled (as if thinking about something difficult). The latter one was accentuated by emphasizing eyebrows and/or a quirky, but still happy, smile. The perspective was either normal perspective (side view) or front view. The consistency of the before and after picture was high: the perspective was not changed and the composition was more or less the same.

Picture 1: Example of picture made by a student (Grade 2)

If to summarise the results, the majority of the grade 2 students like mathematics. Mathematics is connected to positive feeling. Mathematics as a subject is an individual activity - to sit down and work in the textbook. It seems that the motivation is both positive intrinsic (because it is fun and they wants to learn) and negative extrinsic (because the teacher says so and you need to finish the textbook).

Grade 5-6

Just as the responses from grade 2, there is small number of respondents. Therefore no statistical analysis has been made. The data is only presented as descriptive statistics with the purpose to show indications. The results from the post-questionnaire are in brackets.

Statement	Positive (*n*)	Negative (*n*)
What do you think about mathematics?	5 (5)	6 (6)
What do you think about art?	11 (11)	0 (0)
When you have a math class, do you want to do math?	3 (3)	8 (8)

Table 2: Results from quantitative part grade 5-6, *n*=number

From Table 2, we can see that there is more or less a fifty-fifty division between a positive respectively a negative attitude towards mathematics. But in comparison to the attitude toward art class, mathematics comes across as a subject less positive. When summarising the responses to the open-end questions there are a few themes that re-occur. To the question 'Why do you do math?', the most common responses were 'you need for the future', 'I have to ' and 'to learn'. Compared to the grade 2 students where there was an element of joy, here it was not noticeable. This was replicated in the post-questionnaire as well.

The next question was 'How do you feel when you do math?' and the following three themes were the most common ones: (1) it is fun; (2) it is boring; and, (3) it is easy to start to chit-chat. The responses to this question are, just as to statement 1 in the quantitative section, divided into one group that is negative and one group that is positive, but here there is a majority of negative responses. One student writes before the mathematics session that "Often I want to talk when we have math. But sometimes, I want to work." After the class, the student writes " When we have math I want to sleep or talk." Tiredness is mentioned a few times amongst the negative group of the class. When comparing with the post-questionnaire the consistency of the responses is high, but sometimes they are slightly more negative.

The third question was 'What do you do in a math class?'. The majority of the students replied 'calculating' or 'talk'. Some of the other responses were 'work', 'listen to the teacher' and 'waiting'. In the post-questionnaire, the responses are more or less the same.

The results from the picture analysis showed that most students draw themselves alone, sitting down next to a bench working in a textbook just as in grade 2. The most common emotions signalled were calmness or frustration. Some of the students that were negative in the first questionnaire emphasize the negative feelings in the post-picture by using heavier version of the composition, darker presentation and (even) higher pencil pressure. There was a broader use of perspective (side, front or top view), but the chosen perspective was only in a few cases changed in the post-questionnaire. The pressure of the pen was often high, and all students used led pencils. The consistency of the before and after picture was high as shown in Picture 2 and Picture 3.

Picture 2: Example of picture made by a student (Grade 5) before mathematics class. The student wrote “Often I want to talk when we have math. But sometimes, I want to work.”

Picture 3: Example of picture made by the same student (Grade 5) after mathematics class. The student wrote “When we have math I want to sleep or talk.”

If to summarise the results more often negative conceptions are expressed by the grade 5 students compared to the grade 2 students. Just as in grade 2, mathematics is an individual activity where you are sitting down and working in your textbook ('calculating'). There are more negative emotions linked to this activity ('boring') that sometimes this is connected to tiredness. It seems that motivation is both positive and negative, intrinsic and extrinsic: the need for the future could be interpreted in both ways, and the same goes for the need to learn. But overall, the collective impression is that there are more negative responses.

DISCUSSION

This paper aims to investigate younger students conceptions about mathematics and mathematics education with a special focus on motivation. The research questions posed were: (1) What is mathematics according to students in grade 2 and grade 5?; (2) What is their motive to do mathematics?; and, (3) According to the students, how do they feel when they are doing mathematics? Since there was only a small sample of respondents in both groups, this paper only talks about indications. Both groups describe mathematics as an individual activity taking place in a school bench. To work in mathematics is to calculate, to work in a textbook. This is similar to the results from the latest school inspection where the most common observed activity was students working alone (or in small groups) in their textbooks (School inspection, 2009).

There are a larger proportion of positive emotions and positive attitudes towards mathematics expressed in grade 2 compared to grade 5. This result is in the same line as the results from the report from the School agency (Skolverket, 2003). The motivation is primarily in grade 2 positive intrinsic (because it is fun and they wants to learn) and negative extrinsic (because the teacher says so and you need to finish the textbook), whereas in grade 5 it is more complex. This could be explained that grade 5 students in general might perceive their situation a bit more complex with explicit assessments such as national tests. There is also an awareness of the future, an aspect that grade 2 students do not show. Overall, there are more negative responses by the students in grade 5. This was for instance noticeable in the pictures where the most common feeling expressed in the pictures made by the grade 2 students was happiness sometimes combined with a quirky thoughtfulness, although still happy. In grade 5, there was a division between calmness and frustration. Not many of the older students used happy feelings in their pictures.

Another aim of this study is to test picture-creating as a method to grasp more about younger students conceptions about mathematics and mathematics education compared to just using questionnaire with statements and open-end questions. In this study the pictures enhanced the feeling already given in the questionnaire. Positive feelings were combined with happy faces (grade 2) or calmness (grade 5-6). Negative feelings were illustrated with dark and heavy compositions using emotions such as frustration. The pictures also illustrated what is means 'to work in textbook' and 'to

calculate'. The responses in the questionnaire and the post-questionnaire are very similar. Very few changes are made both in the quantitative part and the qualitative part including the open-end questions and when creating a picture. This would indicate that the reliability for the method is rather high. However, the reliability would most likely increase if to combine this questionnaire with interviews. The next step would be to conduct this study with a larger group of students.

References

Borgersen, T. & Ellingsen, H. (1994). *Bildanalys*. Lund: Studentlitteratur.

Hannula, M. (2006). Motivation in mathematics: Goals reflected in emotions. *Educational Studies in Mathematics*, *63 (2)*, 165-178.

Hannula, M. (2007). Finnish research on affect in mathematics: blended theories, mixed methods and some findings. *ZDM*, *39 (3)*, 197-203.

Ryan, R. M. & Deci, E.L. (2000). Self-determination theory and the faciliation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55, 68-78

Schoenfeld, A.H. (1985). *Mathematical Problem Solving*. Orlando, FL: Academic Press.

Schoenfeld, A.H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense-making in mathematics. In D. Grouws (Ed.), *Handbook for research on mathematics teaching and learning* (pp. 334-370). New York: Macmillan.

Skolinspektionen (2009). *Undervisning i matematik – utbildningens innehåll och ändamålsenlighet*, Rapport 2009:5, Stockholm.

Skolverket (2003). *Lusten att lära*. Stockholm: Liber.

Thompson, A.G. (1992). Teachers' beliefs and conceptions: A synthesis of the research. In D. Grouws (Ed.), *Handbook for research on mathematics teaching and learning* (pp.127-146). New York: Macmillan.