“MATHEMATICS IS IMPORTANT BUT BORING”:
STUDENTS’ BELIEFS AND ATTITUDES
TOWARDS MATHEMATICS
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Students’ beliefs and attitudes towards mathematics teaching and learning is the focus of the study described in this paper. Some preliminary results from research carried out in Norway in 2005 are given, which focus on first year students in upper secondary school. The answers from the ninth grade students in 2005 are briefly compared with students’ responses from 1995 when corresponding data was collected within the KIM project in Norway. Both of these studies use a questionnaire elaborated in 1995. Some of the aspects related to a similar study amongst Estonian students, that will take place in spring 2006, are also discussed.

INTRODUCTION

Students’ beliefs and attitudes towards mathematics teaching and learning play an important role in mathematics education (McLeod, 1989). The learning outcomes of students are strongly related to their beliefs and attitudes towards mathematics (Furinghetti & Pehkonen, 2000; Leder, Pehkonen, & Törner, 2002; Pehkonen, 2003; Schoenfeld, 1992; Thompson, 1992). Like Lester, Garofalo, and Lambdin Kroll (1989) point out:

Any good mathematics teacher would be quick to point out that students’ success or failure in solving a problem often is as much a matter of self-confidence, motivation, perseverance, and many other noncognitive traits, as the mathematical knowledge they possess. (p. 75)

Thus assessing or evaluating students’ mathematical knowledge must be made with the awareness of their beliefs. Systematic inquiry into students’ affective domain has grown a great deal during the last twenty years and many countries have been included in the research (Lester, 2002). The study described in this paper aims to find out what kind of beliefs and attitudes towards mathematics Norwegian students hold. This study is part of a larger research project that includes two countries - Estonia and Norway. The general idea of the larger study is to expose Estonian and Norwegian students’ attitudes and beliefs about mathematics teaching and learning, some reasons why these kinds of beliefs are held and any possible relationship between students’ beliefs and attitudes and their mathematical performance. This paper presents some preliminary results from the Norwegian study as the study is ongoing. The research question (that is one of the four questions of the larger study) can be formulated:
What kind of beliefs and attitudes towards mathematics teaching and learning do students from one urban area in Norway hold?

SOME THEORETICAL CONSIDERATIONS

To find a well-developed, well-defined theoretical framework in the study of beliefs and attitudes is a challenge and the endeavour to develop one coherent framework for this area has been the aim of several workshops in different conferences, for example, the 28th Conference of the International Group for the Psychology of Mathematics Education (PME) in 2004. According to Hannula (2004) ‘there is a considerable diversity in the theoretical frameworks used in the conceptualisation of affect in mathematics education’ (p. 107). Goldin (2004) supports that point of view by acknowledging that ‘we do not have a precise, shared language for describing the affective domain, within a theoretical framework that permits its systematic study’ (p. 109). Therefore we do not present one final coherent theoretical framework for our study in this section but rather describe different notions and discuss the relationship between their conceptions.

As belief and attitude ‘are not directly observable and have to be inferred, and because of their overlapping nature’ (Leder & Forgasz, 2002, p. 96) it is problematic to have a common definition of these notions. Several researchers do not see the possibility of isolating these concepts and define an attitude as a collection of beliefs (e.g. Rokeach, 1972; Sloman, 1987) or classify belief as one component of attitude (e.g. Aiken, 1980; Statt, 1990). Cooper and McGaugh (1970) make a useful clarification when they note that

… one has an attitude toward and a belief in or about a stimulus object… Belief connotes an attitude which involves or identifies the subject deeply with the object. (p. 12, emphasis original)

Different researchers relate the notion belief to different aspects. For example, Kloosterman (2002) sees a direct connection between belief and effort. Some researchers classify beliefs as a subclass of conceptions (Hart, 1989; Thompson, 1992), others explain conceptions as a subset of beliefs (Pehkonen, 1994). Schoenfeld (1992) talks about beliefs as an individual’s feelings and understandings. A considerably wide definition is given by Rokeach (1972) who claims:

A belief is any simple proposition, conscious or unconscious, inferred from what a person says or does, capable of being preceded by the phrase “I believe that…” (p. 113)

The definitions of belief and attitude formulated in this paper are adopted from Pehkonen (2003) and Triandis (1971) as we found them most suitable for our study. Triandis (1971) explains the concept of an attitude by the following words:

Attitudes involve what people think about, feel about, and how they would like to behave toward an attitude object. Behaviour is not determined by what people would like to do but also what they think they should do, that is, social norms, by what they have usually
done, that is habits, and the expected consequences of behaviour. (p. 14, emphasis original)

This definition takes into account two aspects that are relevant for us. Firstly, it points out two basic verbs. To think relates to the person’s cognitive domain. To feel can be considered to be relevant when the affective domain is under discussion. The study described here uses a questionnaire for illuminating mostly students’ thinking about the mathematics, however the larger study includes lesson observations and interviews to expose some feelings that will be interpreted based on the behaviour. Therefore, both conceptions are relevant. Secondly, the definition includes the social perspective that points out several factors that influence students’ beliefs and hence their behaviour (see Pehkonen, 1995 for more detail) and how cautious one must be in drawing conclusions based on the sources (questionnaire for example) as one can never claim that the environment around the informant does not have any influence of her/his thinking and behaviour (answering to the questionnaire for example).

Pehkonen (2003) follows the similar idea and does not situate beliefs in the human affective domain but somewhere between the cognitive and affective domains, in what he calls the “twilight zone”, as he argues that beliefs have ‘a component in both domains’ (p. 1). He understands

| beliefs as an individual rather stable subjective knowledge, which also includes his/her feelings, of a certain object or concern to which tenable grounds may not always be found in objective consideration. (Pehkonen, p. 2)

We agree as the interplay between the thinking and the feeling is unavoidable because on the one hand beliefs are a part of persons’ knowledge that is highly subjective and on the other hand the conceptions feelings and beliefs are often overlapping and cannot be distinguished.

THE KIM PROJECT

One of the studies of which the results are discussed briefly in this paper was carried out in Norway in 1995 amongst students from the grades 6 and 9. It was called the KIM1-project and it collected data on students’ understandings of key concepts in the national mathematics curriculum (Streitlien, Wiik, & Brekke, 2001). This project elaborated a questionnaire (later called the KIM questionnaire) that contained 125 items designed to expose students’ beliefs about mathematics, mathematics teaching and learning. The KIM questionnaire used Likert–scale type responses. Leder andForgasz describe the Likert–scale in the following terms:

A series of statements about the attitude object comprise a Likert-scale. Items are typically rated from “strongly agree” to “strongly disagree” and five divisions are very common. (2002, p. 98)

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1 KIM – Kvalitet i Matematikkundervisningen, translated as ‘Quality in Mathematics Teaching’.
The questionnaire was administered to 1482 students from 6th grade and 1183 students from 9th grade. Some of the results are compared with the results from year 2005 and will be reviewed later in this paper. Within the same project students’ mathematical performances and their attitudes were investigated. Students’ (273 from grade 6 and 234 from grade 9) responses to mathematics tests were compared to the questions about their professed beliefs and attitudes towards mathematics and its teaching and learning. The study concluded: Those pupils who state a positive interest towards mathematics, on average, performed better on the mathematics tests than their fellow students (Streitlien, Wiik, & Brekke, 2001).

METHOD

Research participants

Our study, carried out in spring 2005 in Norway, was one part of the LCM-project within the Norwegian Research Council’s KUL² programme. Our interest embraced students’ beliefs and attitudes towards mathematics teaching and learning and our informants were students from grades 7, 9, and first year in upper secondary school. Six schools from one urban area in Norway that are partners in the KUL-LCM project took part, and about 370 students were involved in our study.

Data sources

Based on the literature, the questionnaire can be considered as a common instrument to study beliefs and attitudes (Leder & Forgasz, 2002) and several researchers use it as a main tool (e.g., Graumann, 1996; Pehkonen, 1994; Pehkonen, 1996; Pehkonen & Lepmann, 1994; Perry, Howard, & Tracey, 1999; Tinklin, 2003; Tsamir & Tirosh, 2002; Vacc & Bright, 1999; Williams, Burden, & Lanvers, 2002). In our study we used virtually the same questionnaire as the KIM study. Some changes were carried out in response to our research questions and the data from the pilot study (see Kislenko, Breiteig, & Grevholm, 2005). Hence, our questionnaire contained 126 statements divided into 13 groups which were beliefs about: mathematics as a subject (16 statements); learning mathematics (14); own mathematical abilities (11); own experiences (security) during mathematics lesson (4); teaching of mathematics (17); learning a new topic in mathematics (8); environment in class (10); teaching tools in mathematics lessons (6); using computer in spare time (2); using ICT in mathematics (computer) (18); own evaluation of importance of mathematics (8); evaluation of the teacher (10); mathematics and the future (2).

For example, statements in the class “new topic in mathematics” were: “the teacher starts by giving us rules”; “we start with a practical problem from a daily life”; “the

² KUL – Kunnskap, utdanning og læring, translated as ‘Knowledge, education and learning’.
teacher asks us what we know about the new topic”; “the teacher leaves the textbook to decide what to do”, etc.

Following Gorard’s (2001) advice ‘since there may be so little similarity between responses to forced-choice and open-ended questions it is probably advisable to mix the types of questions in any instrument’ (p. 93), some open ended questions were included too in the questionnaire. One other dissimilarity with the KIM questionnaire was that our questionnaire was web based, that is students filled up the questionnaire which was made available on an Internet webpage. Each student was issued with a unique code which she/he used to log into the questionnaire page.

RESULTS

As mentioned above we collected our data in spring 2005 and closed the questionnaire on 15th June. Therefore, the analysis presented below is preliminary. Deep and structured data analysis is due to start during the autumn 2005. But some initial and tentative results are given in the following subsections. First, the data from the KIM project is compared with the data from our project with focus mainly on grade 9. Then, there are some preliminary results from our research with focus on students in upper secondary school. The answers from grade 9 students and first year students in upper secondary school are compared. And finally, some considerations concerning a relationship between mathematical performance and beliefs are discussed.

Comparison between the studies

Out of 90 grade 9 students included in the study, 85 completed the questionnaire. Thus, the response rate (c 94.4 %) was very high in these classes. Based on the approach by Streitlien, Wiik, and Brekke (2001) we formed 5 groups of statements about mathematics: interest, usefulness, self-confidence, diligence, and security. In the following table (Table 1) some results from our study are compared with the results from the KIM study. The statements are taken from the groups interest and usefulness. The columns in the table refer respectively: totally agree (Ta), partially agree (Pa), uncertain (U), partially disagree (Pd), and totally disagree (Td). The following discussion is not only based on Table 1 but on all the data from the questionnaires. Only a small part of data is presented due to limited space.

<table>
<thead>
<tr>
<th>Interest and usefulness</th>
<th>Ta</th>
<th>Pa</th>
<th>U</th>
<th>Pd</th>
<th>Td</th>
</tr>
</thead>
<tbody>
<tr>
<td>1b Mathematics is exciting and interesting.</td>
<td>13</td>
<td>50</td>
<td>18</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>1b Mathematics is exciting and interesting KIM.</td>
<td>8</td>
<td>36</td>
<td>18</td>
<td>22</td>
<td>15</td>
</tr>
<tr>
<td>1i I never get tired of doing mathematics.</td>
<td>8</td>
<td>9</td>
<td>15</td>
<td>38</td>
<td>29</td>
</tr>
<tr>
<td>1i I never get tired of doing mathematics KIM.</td>
<td>3</td>
<td>11</td>
<td>12</td>
<td>36</td>
<td>38</td>
</tr>
<tr>
<td>1j I like to do and think about mathematics also out of school.</td>
<td>2</td>
<td>19</td>
<td>13</td>
<td>32</td>
<td>33</td>
</tr>
</tbody>
</table>
I like to do and think about mathematics also out of school KIM.

Mathematics helps me to understand life in general. 18 31 26 15 10

Mathematics helps me to understand life in general KIM. 6 20 31 23 19

Mathematics helps those who make important decisions. 15 32 29 18 6

Mathematics helps those who make important decisions KIM.

Mathematics is boring. 15 37 15 18 14

Mathematics is boring KIM. 25 29 13 22 10

Good mathematical knowledge makes it easier to learn other subjects. 25 32 21 14 7

Good mathematical knowledge makes it easier to learn other subjects KIM.

As can be seen from Table 1 and our data generally there seems to be a small tendency towards more positive beliefs about mathematics amongst students from the 2005 survey. Students’ views tend to be more radical and they are more certain in their statements, especially in relation to the usefulness of the mathematics. Students agree more that mathematics is useful in different situations in life and acknowledge that being good in mathematics helps to learn other subjects. The comparison in the groups of self-confidence and diligence did not give any considerable dissimilarity. Most of the students find that mathematics is a difficult subject and they have to work hard and solve many exercises to be good at mathematics. Students from both studies (around 85 %) understand that it is their responsibility to learn mathematics and acknowledge mathematics to be a subject which increases in difficulty as they progress through the grades. Nevertheless, there is still a close match of agreement that mathematics is boring. This conclusion is rather striking in the situation where 97 % of students say that mathematics is important. It means that students have a high motivation to learn but for some reasons they are bored in the mathematics lessons. Indeed, the technology that can help teachers to make mathematics lessons more challenging and fascinating has developed enormously during these 10 years (1995-2005) but the phenomenon of “being bored” in mathematics lessons is still quite common amongst the students in grade 9. What can be the reasons for this phenomenon? Is it only the matter of mathematics as a school subject or is it something else that is hidden behind the scenes?

**Upper secondary school compared to 9th grade – comparison within the study**

There were 160 first year students from upper secondary school who completed the questionnaire. The following table (Table 2) has a similar construction to Table 1 but

<table>
<thead>
<tr>
<th>Table 1: Interest and usefulness 1995 and 2005. Frequencies in percentages.</th>
<th>3 9 13 31 44</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics helps me to understand life in general.</td>
<td>18 31 26 15 10</td>
</tr>
<tr>
<td>Mathematics helps me to understand life in general KIM.</td>
<td>6 20 31 23 19</td>
</tr>
<tr>
<td>Mathematics helps those who make important decisions.</td>
<td>15 32 29 18 6</td>
</tr>
<tr>
<td>Mathematics helps those who make important decisions KIM.</td>
<td>13 28 38 12 8</td>
</tr>
<tr>
<td>Mathematics is boring.</td>
<td>15 37 15 18 14</td>
</tr>
<tr>
<td>Mathematics is boring KIM.</td>
<td>25 29 13 22 10</td>
</tr>
<tr>
<td>Good mathematical knowledge makes it easier to learn other subjects.</td>
<td>25 32 21 14 7</td>
</tr>
<tr>
<td>Good mathematical knowledge makes it easier to learn other subjects KIM.</td>
<td>14 29 36 14 7</td>
</tr>
</tbody>
</table>
now the students from 9th grade are compared with students from first year of upper secondary school (later UppSec) inside of our study to see if there are any tendencies towards students’ progress through the grades. The group of *usefulness* is chosen since the differences within this group are most noticeable.

![Table 2: Usefulness. Grade 9 and first year in upper secondary. Frequencies in percentages.](image)

An aggregate value was formed for this group of items to get a better insight into the differences. This technique follows Streitlien, Wiik, and Brekke (2001). The items were coded so that positive interest always gave high values, for example:

| Usefulness                                                                 | || || || |
|---------------------------------------------------------------------------|---|---|---|---|---|
| 1a Mathematics is important G. 9.                                         | 75 | 22 | 0  | 0  | 2  |
| 1a Mathematics is important UppSec.                                       | 54 | 32 | 9  | 5  | 1  |
| 1e Mathematics is useful for me in my life G. 9.                          | 66 | 20 | 7  | 5  | 2  |
| 1e Mathematics is useful for me in my life UppSec.                        | 37 | 40 | 8  | 10 | 5  |
| 1f It is important to be good at mathematics in school G. 9.              | 51 | 36 | 8  | 2  | 2  |
| 1f It is important to be good at mathematics in school UppSec.            | 26 | 53 | 10 | 9  | 2  |
| 1g I need mathematics in order to study what I would like after I finish school G. 9. | 41 | 27 | 18 | 5  | 9  |
| 1g I need mathematics in order to study what I would like after I finish school UppSec. | 31 | 21 | 28 | 12 | 9  |
| 1k Mathematics helps me to understand life in general G. 9.               | 18 | 31 | 26 | 15 | 10 |
| 1k Mathematics helps me to understand life in general UppSec.             | 6  | 27 | 22 | 24 | 21 |
| 1l Mathematics helps those who make important decisions G. 9.             | 15 | 32 | 29 | 18 | 6  |
| 1l Mathematics helps those who make important decisions UppSec.           | 9  | 28 | 35 | 14 | 13 |
| 1o I do not need to know mathematics G. 9.                                | 4  | 6  | 11 | 26 | 54 |
| 1o I do not need to know mathematics UppSec.                              | 8  | 10 | 17 | 30 | 35 |
| 1p Good mathematical knowledge makes it easier to learn other subjects G. 9. | 25 | 32 | 21 | 14 | 7  |
| 1p Good mathematical knowledge makes it easier to learn other subjects UppSec. | 19 | 48 | 21 | 8  | 5  |
Mathematics is important (from 5 = “totally agree” to 1 = “totally disagree”) and I do not need to know mathematics (from 1 = “totally agree” to 5 = “totally disagree”).

A scale was made from the 8 items of Table 2. A new variable is an opinion that mathematics is useful. Table 3 shows the average of the responses to the eight items distributed by grade.

<table>
<thead>
<tr>
<th>Usefulness of mathematics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 9</td>
<td>3.96</td>
</tr>
<tr>
<td>First year in upper secondary school</td>
<td>3.62</td>
</tr>
</tbody>
</table>

Table 3: Usefulness of mathematics. Average of items in Table 2. Neutral value 3.

Two issues in Table 3 drew our intention. Firstly, both values are higher than the average value (which is 3) which indicates that students at both levels consider mathematics to be highly useful and this corresponds to the conclusions made earlier in this paper. Secondly, there is a considerable decrease (0.34) in perception of usefulness between the students from grade 9 and first year in upper secondary school. These results are similar to the results from the KIM study. Streitlien, Wiik, and Brekke (2001) point out that one of the possible reasons could be an effect of a decreasing general motivation for schooling. It also might be related to the content of the subject as mathematics becomes more difficult and abstract as students progress through the grades.

To illustrate other aspects we made the same kind of comparison within the other four groups and made a similar synthesis (Table 4).

<table>
<thead>
<tr>
<th>Groups of items</th>
<th>Grade 9</th>
<th>First year in upper second.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest</td>
<td>2.75</td>
<td>2.79</td>
</tr>
<tr>
<td>Self-confidence</td>
<td>3.09</td>
<td>3.09</td>
</tr>
<tr>
<td>Diligence</td>
<td>4.02</td>
<td>4.00</td>
</tr>
<tr>
<td>Security</td>
<td>3.47</td>
<td>3.40</td>
</tr>
</tbody>
</table>

Table 4: An average of the items in different groups. Neutral value 3.

Table 4 reveals that there appears to be little difference between the students from grade 9 and first year in upper secondary school.

Some interesting results from our study include:

- 86 % of students agree that mathematics is important and 77 % acknowledge the usefulness of mathematics in their lives.
- 48 % claim that mathematics is boring, while 65 % are sure they need to know mathematics.
• Most students understand that they have to work hard even if they do not enjoy working with mathematics in lessons (76 %) and it is their responsibility to learn mathematics (89 %).
• All the students, except one, find it important to know something about numbers and calculations and only two students think it is unimportant to know how to solve practical problems.
• There is still a huge emphasis on “mental calculations” amongst the first year students in upper secondary school as 96 % acknowledge that it is important to become good at this.

These are only some general results from our study in one urban area in the southern part of Norway. The deeper data analysis will enlighten more the issues of our interest, and some reasons behind the kinds of answers that we got from our respondents will be discussed in the future.

The analysis of the relationship between students’ performances and their beliefs

Andreassen explored the mathematical performance of the same students who participated in our attitude study using a written mathematics test and presented the results in her master’s thesis (Andreassen, 2005). We plan to complement her study by investigating the relationship between students’ performance and beliefs as the study progresses. The coding process of the students in both studies makes that analysis possible. Streitlien, Wiik, and Brekke (2001) note that there occurred a significant connection between the performance of the mathematical test and the self-confidence in mathematics in the KIM study. We have an idea that a positive attitude towards mathematics and the teaching of the subject leads in general to the motivation of students to learn more, and conversely, high performance in mathematics, combined with the experience that one achieved well in the subject, leads to positive attitudes towards mathematics. Presenting our results according to a possible relation between attitude and achievement we take seriously into consideration a caution by Cockcroft (1982) who warns that despite the teacher’s perception that more interesting and enjoyable work will lead to greater attainment … research certainly suggest caution against overoptimism in assuming a very direct relation between attitude and achievement. (p. 61)

BRIEF INTRODUCTION TO OUR FUTURE RESEARCH IN ESTONIA

The research in Estonia is planned to take place in the spring 2006. About 10 schools from one urban area in Estonia will participate. These schools will be selected from schools which collaborate and take part in a school-practice program with Tallinn University. Part of the data will be gathered through the same questionnaire (translated into Estonian) which we used in our Norwegian study. To get insights into the reasons behind the attitudes, qualitative methods will be included. Therefore, lesson observations and interviews are planned (in grade 7, grade 9, and first year in
upper secondary school) during a two months period. The supposed number of lessons observed in a week is about 10. Individual interviews with the teachers will start before the lesson observations and will be carried out frequently during the observation process. Students will be grouped according to their answers in the attitude questionnaire and these groups will comprise students who hold more or less similar attitudes towards mathematics (for example, “positive”, “rather neutral”, and “negative”). This in order to get a common characteristic of groups for a better understanding of the reasons behind students’ attitudes. Personal interviews with the students are not planned yet, but if there turns out to be a need for having them, it is not excluded.

According to the TIMSS study in 2003, Norwegian students tend to have a significantly higher level of self-confidence than students from Estonia (Mullis, Martin, Gonzalez, & Chrostowski, 2004). We hope that our Norwegian and Estonian studies will help to illuminate the reasons for this phenomenon.

Acknowledgement
The project LCM is supported by The Research Council of Norway within its KUL program, ‘Kunnskap, utdanning og læring’ (‘Knowledge, education, and learning’, Norges Forskningsråd, project no. 157949/S20).

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