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MEASURING IMMEASURABLE VALUES
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This paper critically explores research on values in mathematics education from a methodological perspective. In the contexts of conducting large-scale international collaborations and comparisons we problematize the interpretation of learning activities as indicators of a certain value. Interviews with students supported our work, and we argue that a learning activity can be interpreted out of different categories of values, depending on the context.

Keywords: mathematics, mathematical values, cultural values, contexts, methodology.

INTRODUCTION

Values like the prize of gold on the market are values that are easy to measure and compare. Values that guide students when they decide what is important when learning mathematics are difficult to measure, and even more difficult to compare. Still, this is the aim of the Third Wave project.

The Third Wave Project (Seah & Wong, 2012) was initiated 2008 in Monash University in Melbourne, Australia. It is an international research project investigating teachers’ and students’ values in mathematics learning in different cultures. The relation between values and learning activities can help us understand why lessons are different in different cultures. A second aim is to develop a survey tool to continue investigating values, independently of culture (see Seah, this volume). This paper concerns Study 3 within the project: “What I find important (when learning mathematics)” (WiFi). WiFi is a survey study, conducted in countries as Australia, Brazil, China, Hong Kong SAR, Malaysia, Singapore, Sweden, Taiwan, Turkey and the US. This large-scale investigation consists of a Web Based questionnaire with 89 questions, some multiple choice and some open questions. It is to be distributed to 11 and 15 year old students in the different countries. Stockholm University is coordinating the Swedish part of the study.

Our task as the Swedish team was to translate the quantitative questionnaire, developed in an Australian-Asian context, into Swedish with possibilities to, first, research Swedish students’ values and, second, to be able to make international comparisons. The aim of this paper is to problematize the interpretation from the posed questions, as a value indicator, to a certain value.

THEORETICAL BACKGROUND

Values in mathematics education are “the deep affective qualities which education fosters through the school subject of mathematics” (Bishop, 1999, p. 2). However, according to Hannula (2012), there is a terminological ambiguity in the research field of mathematics-related affect. Hannula describes the ambiguity if values researched are values by the individual or the community. Seah & Wong (2012) take the stance
that “values are regarded in [the Third Wave project] from a sociocultural perspective rather than as affective factors.” To give one example, Andersson and Seah (2012) demonstrated, with a socio cultural theoretical perspective the complex interplays amongst learning contexts, the valuing involved, and student agency when analysing the Swedish student Sandra’s narratives over a year’s participation in mathematics class. While changes in learning contexts lead to variations in student agency with regards to engagement, Sandra’s story demonstrated the interplays between what these contexts value and whether these values are aligned (or not) with what Sandra values as a learner.

The diversity of values has meant a need to differentiate amongst the many values that are portrayed in the classroom. Bishop (1996) emphasised three categories of values in the (Western) numeracy classroom, namely, mathematical, mathematics educational, and general educational. To investigate cultural values, the project uses the theoretical framework of Hofstede and Hofstede (2005).

In the WIFI-study, the three categories (mathematical values, mathematic educational values and cultural values) all have sub-dimensions of values, and the study deals with a set of 24 different values. Children responding to the questionnaire cannot be expected to relate directly to a value; hence, the questions posed are about different learning activities, regarded as value indicators. Seah and Peng (2012) conducted a scoping study in Sweden and Australia, where students were asked to write down or take photos when they found themselves learning mathematics well. The learning activities pictured were treated as value indicators, and the results allowed the researchers to reflect on the problem of making a difference between a value and a value indicator.

![Figure 1: Categorisation of values from value indicators](image)

Here, the indicator is analysed within three categories of values. In every category, there are several value dimensions.

An example of how figure 1 is used may be useful. In the designing stage of the WIFI questionnaire, the learning activity “Learning the proofs” is categorized as an indicator of the mathematical value of rationalism (see Bishop, 1988), and “Doing mathematics by myself” is categorized as an indicator of the cultural value of individualism (see Hofstede 2005).
In this paper, the mathematical value dimensions used are the mathematical values of rationalism, objectism and control. Rationalism is central in mathematics; it is about valuing reasoning and proof. Objectism emphasizes that mathematics is constructed from objects by an axiomatic system, and can be applied and concretised. The value control emphasizes procedures and mastery of rules. The Mathematical Educational value dimensions used in this paper are application, computation, recalling and effort.

The cultural values dimensions have an impact on several areas in society, from family to companies, and Hofstede and Hofstede (2005) also ascribe its impact on education. In this paper, we discuss the cultural value dimensions of individualism, as opposed to collectivism, and uncertainty avoidance. In an individualist culture, knowledge is valued differently from in a collectivist culture. The purpose of learning in an individualist culture is less to know how to do than to know how to learn. The assumption is that learning in life never ends; even after school and university learning will continue (e.g. through post academic courses). The individualist society in its schools tries to provide the competencies necessary for the “modern man” (Hofstede & Hofstede 2005, p. 98). A collectivist society in its schools values knowledge that is beneficial for the society. A diploma is also valued differently, in an individualist society, a diploma gives the holder a better economic status but it also improves his/her self-respect. In a collectivist society, a diploma provides entry to higher-status groups.

Valuing uncertainty avoidance in school is about wanting structure and right-answer-questions rather than open-ended questions (Hofstede & Hofstede, 2005). Students do not question teachers or textbooks; they demand them to be correct. Hence, their own results are being attributed to circumstances or luck. The opposite position, a culture with weak uncertainty avoidance, is one in which students are expected to be rewarded for originality; and one in which results are attributed to a person’s own ability.

To be able to analyse the relation between value indicators and values, a few earlier Swedish studies were consulted. The Swedish School Inspectorate (2009) made an assessment on mathematics teaching in Sweden. It concluded that Swedish teachers were still relying then on the textbook when teaching mathematics. Instead of relying on the curriculum, they trust the textbook to address all mathematics needed. The focus is often the practicing of calculation procedures. The historical development might have influenced this. Lundin (2008) concludes that historically, the focus has been on learning calculation procedures. He writes that “This need led to the promotion of schoolbooks filled with a large number of relatively simple mathematical problems, arranged in such a way that they (ideally) could keep any student, regardless of ability, busy – and thus quiet – for any time span necessary.” (p. 376). These students’ experiences are reinforced in the context of Swedish mathematics education; according to Lindqvist, Emanuelsson, Lindström and Rönnberg (2003), textbooks in Swedish mathematics education seemed to define the essence of school mathematics. This way of organizing mathematics education is believed to support teachers in managing non-homogeneous group of students so that each student could work according to his/her previous learning and needs, as well as following curriculum and reform concerns (Johansson, 2006).
Taking another viewpoint, Björklund Boistrup (2010) showed four assessment discourses in Swedish classrooms when researching students’ semiotic resources and assessment acts. She labelled one assessment discourse “Do it quick and do it right”. Within such a discourse, we can expect teachers and students to value activities that allow them to practice calculating procedures. However, she also describes an assessment discourse labelled “Reasoning takes time”, where the teacher assess mathematical reasoning. Another Swedish example is the different learning contexts Sandra, in the example above, participated in.

The aim of the Swedish mathematics curriculum emphasises the school subject of mathematics as problem solving, application, methods, reasoning and concepts. Problem solving has a status not as an application of mathematics, but as a part of mathematics. ”Teaching in mathematics should essentially give students the opportunities to develop their ability to:/…/ formulate and solve problems using mathematics and also assess selected strategies and methods” (Ministry of Education, 2011).

Despite those different aims and learning contexts, is there a way of describing common values in Swedish mathematics education?

**METHODODOLOGY**

In order to better relate the value indicators to an appropriate value, we conducted short scoping interviews (Kvale & Brinkman, 2010) with eleven Swedish students, aged 10-15 years old. The students were asked to elaborate on two open questions: “What do you find important when learning mathematics?” (The name and aim of the questionnaire) and “How would you design maths lessons if you were to decide yourself?” The students’ responses were then categorised to match the questions in the questionnaire with the purpose to indicate the correspondences between indicators and values in the Swedish context.

**Analysis**

This is an example to describe the analysis process.

**Interviewer:** What do you find important when learning mathematics?

**Student:** I calculate in my textbook and I do homework. (Jag räknar i matteboken och jag gör läxor)

First, the interview answer is regarded as our value indicator. Second, we analyzed the correspondence between the student’s interview answers and the questions in the questionnaire. Question 57 in the WIFI-questionnaire says “Homework”, so there is a corresponding question to one part of the students answer. Question 36 says “Practicing with a lot of questions”. There is a certain correspondence to “calculate in my textbook”. Third, the questions that appeared most frequently in the interviews were chosen for a categorization out of all three value categories (mathematical values, mathematics educational values and cultural values) and the underlying value dimensions. In this analysis process, we use the motivations expressed in interviews by
the students, as well the theoretical frameworks described for values, as well as research about traits in Swedish mathematics education.

RESULTS

When comparing the answers students gave in the interviews to the questions in the questionnaire, four questions matched several answers. Those questions are: A) “Problem solving” (six students), B) “Knowing the times tables” (multiplication tables), (six students), C) “Practicing with lots of questions” (seven students) and D) “Connecting maths to real life” (three students).

Questions B) and C): “Knowing the times tables” and “Practicing with lots of questions”

Students mentioned different calculation abilities, “knowing the times tables” was the most common, but addition (“tiokamrater”, “additionstabellen”) was also mentioned. We related all those answers to the question “Knowing the times-tables”. These are examples of activities where it is important “to do it quick and do it right” (Björklund Boistrup, 2010). Five students, 10-13 years old, gave answers that we related to the question “practicing with lots of questions”, even though what they said was “working in the textbook”. Four students, 13-15 years old, said that they found it not rewarding or discouraging to work in textbooks, and they wanted mathematics teaching to contain more problem-solving activities, implying that problem solving tasks were missing in the textbook.

In the WIFI Research Guidelines, the question “Knowing the times tables” is categorised as an indicator of the mathematics educational value of recalling, and “Practicing with lots of questions” is categorised as an indicator of the valuing of effort. What the Swedish students actually said was “working in the textbook”, not “practicing with a lot of questions”. The Swedish School Inspectorate (Rapport, 2009, p. 5) found that working in the textbook is practicing procedural calculations. We argue, from the Swedish learning context, that is also an indicator of the mathematical value of control, concerned with the mastery of rules and procedures.

The question formulates “Getting the right answer”. We interpret both “knowing the times tables” and “Practicing with a lot of questions” as similar indicators, you are likely to get the right answer if you know the times tables or practice with a lot of questions. For this reason, we argue that these questions are also indicators of the cultural value of uncertainty avoidance. In the uncertainty avoidance-dimension, Sweden ranks 48/49 out of 53 countries (Hofstede & Hofstede, 2005). This means that there is a weak uncertainty avoidance in Sweden. In school, uncertainty avoidance is about wanting structure and right-answer-questions rather than open-ended questions. Students do not question teachers or textbooks, they demand them to be correct, and their own results are being attributed to circumstances or luck. The opposite position, which goes for Sweden, is students expected to be rewarded for originality; results are attributed to a person’s own ability. The younger students’ answer, that it is important to do procedural activities, contradicts the common Swedish value. But when the older students express that they want less work in the textbooks and more problem solving,
this can be interpreted as an indicator of weak uncertainty avoidance, and of the students socialising themselves into the Swedish society.

**Questions A) and D): Problem solving and Connecting maths to real life**

Five of the older students mentioned problem-solving, mostly in the context that they liked problem-solving and wanted more problem solving activities, rather than working in a textbook. In the research guidelines, problem solving is categorised as an indicator of Mathematical Educational Value of Application.

It is not obvious what students are valuing when they say problem solving. It might be a way of them to express “doing something else than working in the textbook”, as they do not have the vocabulary to express any alternative but problem solving. They gave a variety of explanations why they prefer problem solving, like working together, more variation, teacher solves problems, more fun, learn differently, working in pairs and share ideas.

If problem solving is considered as a part of mathematics rather than a tool for learning mathematics, as it is described in Swedish curriculum, it is more relevant to categorise it as one of Bishops (1996) Mathematical values, the mathematical value of objectism, where applying mathematical ideas is emphasized. From our interviews it is hard to determine whether students view problem solving as a mathematical content or a tool for learning.

Concerning cultural value dimensions, Hofstede & Hofstede (2005) describe their impact on education, and in the description of the individualist cultural dimension, there are findings relevant to problem solving. Sweden ranks nr 10/11 out of 53 nations in the individualism/collectivism cultural dimension which means that Sweden is an individualist rather than collectivist society. The purpose of learning in an individualist society is less to know how to do than to know how to learn. An individualist society rather tries to provide the competencies necessary for lifelong learning. (Hofstede & Hofstede, 2005). The question in the WIFI-questionnaire related to this dimension is formulated “Working out the maths by myself”. This is often a part of problem solving in the Swedish context, application can be a part of problem solving, but not always. This is not only a linguistic difference, rather a different practice.

From the discussion above, we argue that problem solving is not only a value indicator of the mathematics educational value of application. In the Swedish learning context it can also be categorised as an indicator of mathematical value of objectism, as well as a cultural value of individualism.

Five of the older students mentioned that mathematics was important for finding a job, or to get a good grade or good education in the future. They value mathematics as an important competence in life. Three answers could be related to the question in the WiFi-questionnaire about “Connecting maths to real life “. In the research guidelines, this is categorised as an indicator of mathematics educational value of application. But from the motivations we got, we argue that this rather indicates a cultural value in the individualism – dimension, in the same way as for the problem solving question. We
also argue that these answers are indicators of the mathematical value of objectism, where students value knowledge of mathematical objects for giving an explanation of real world phenomena.

As a result, we can argue that these four questions can be regarded as value indicators for one value in each one of the value categories proposed, mathematical values, mathematics educational values and cultural values.

CONCLUDING DISCUSSION

In the analysis section above, we have showed that the different categories of mathematical, cultural, and mathematics educational values are related to different value indicators. They can overlap, that is, a particular value indicator may suggest the valuing of one or more categories of values in the mathematics classroom. The individual students’ values are assumed to be influenced by mathematics, mathematics education, culture and probably more at the same time. This means we have to take more into consideration than one check in the “important”-box to determine what value a certain answer indicates. The interpretation will probably vary between cultures, so the WIFI study will give us the distribution of value indicators rather than values. Value indicators can be measured, compared and analysed. Values still seem immeasurable.

REFERENCES


Andersson, Österling


