To Survey what Students Value in Mathematics Learning

Translation and adaptation to Swedish language and context of an international survey, focusing on what students find important in mathematics learning.

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Abstract

This is a methodological thesis of the translation and adaptation process of an international survey questionnaire from an Australian context into Swedish context and language. Stockholm University conducts the Swedish part of this international project. The aim of the questionnaire is to survey what students value as important when learning mathematics. This thesis presents methodological considerations about linguistics, cultural adaption, and adaption to the intended group. Generic problems from the English Source Questionnaire are discussed. Construction and Conclusion validity regarding measuring the value concept is also analysed.

The theoretical frameworks for explaining students valuing of importance are the frameworks of mathematical values, cultural values and a developing theory of mathematics educational values. To be able to adapt the questionnaire and keep the metric equivalence, the interpretation of questions in the questionnaire as value indicators needs to be considered. The nature of values is discussed with respect to how they can be measured.

From developing a value survey tool, the aim of the international project is to be able to do international comparisons of mathematical values in mathematics learning, but also to develop a tool to be used by teachers. The validation process consisted of interviews and pilot testing, and resulted in a Swedish survey questionnaire for measuring what students find important when learning mathematics. My conclusion is that construct validity, which is in this case considerations of what is measured, and conclusion validity, which is what conclusions we can draw from our measures, affect considerations in adapting a survey to a new cultural context.

Keywords
Mathematics education, Values, Survey study methodology, Survey translation methodology, validation
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1 Introduction

1.1 Background of the Project

A few years ago, in France, one of my French friends complained that Euclidian Geometry was to be excluded from the French curriculum. “Euclidian Geometry is the base for understanding mathematics,” he stated. In France, there was a detailed, rather conservative, national curriculum. I agree that Euclidian Geometry sums up important principles of mathematics. It is the origin of modern western mathematics, mathematics based on axioms, with postulates derived by proof and inductive reasoning. In Swedish schools, Euclidian Geometry hasn’t been in the mathematics curriculum for a very long time. It would be hard to find anyone in Sweden, who is not a mathematician, who would say that they miss it.

Swedes and Frenchmen sometimes value different things in mathematics learning. This conversation took place shortly after young people had set Paris’ suburbs on fire, and French education authorities began to reflect on their education system possibly excluding some students, especially students with a non-French cultural background or from working class homes. Maybe those French students will not value Euclidian principles as being as important as my friend did.

This report is about the translation and adaptation of an international survey questionnaire, with the aim of surveying what Swedish students value as important in mathematics learning. The international project, The Third Wave Project (Seah & Wong, 2012) was initiated in 2008 at Monash University in Melbourne, Australia. It is an international research project investigating teachers’ and students’ values in mathematics learning across cultures. Values, like the price of gold on the market, 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.

This thesis concerns Study 3 within the project: “What I find important (in maths learning)” (WiFi). WiFi is a survey study, conducted in following countries: Australia, Brazil, China, Germany, Greece, Hong Kong SAR, Japan, Korea, Macau, Malaysia, Singapore, Sweden, Taiwan, Thailand and Turkey. 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 eleven and fifteen-year old students in the different countries. Annica Andersson at Stockholm University is coordinating the Swedish part of the study. This thesis is a report from the first year in this project. Our first 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. An aim from the main project is to develop a teacher survey tool for researching student values. From here on, I will refer to the international study as WiFi, and the Swedish part will be referred to as VsV “Vad som är Viktigt (när jag lär mig matematik)”.

This project is a team effort, led by Dr. Annica Andersson. Those who have been contributing to the team are, besides me, also my colleagues Anette De Ron, Elisabeth Hector and Charlotta Billing. In the Methodology Chapter I will explain what roles each team member has. In the Results Chapter, I
will use “we” when I refer to decisions or analyses we made as a team, and I will use “I” when I refer to my own decisions or contributions.

1.2 Framing Research on Values in Mathematics Education

Plato stated that there are only three values: truth, good and beauty. Due to Plato, those values are objective. Protagoras and later philosophers describe values as a relative measure. Goodness, truth and beauty are given their value by human individuals, affected by individual or cultural perceptions and beliefs (Oregon State University, 2013).

The Swedish education system is not value-neutral; values are inscribed in steering documents (The Swedish National Agency for Education, 2011). The headline of the first chapter of the Swedish curriculum (English Version) is “Fundamental values and tasks for the school.” Under the sub-title ”Fundamental values” is written:

    Education should impart and establish respect for human rights and the fundamental democratic values on which Swedish society is based. Each and every one working in the school should also encourage respect for the intrinsic value of each person and the environment we all share.

    (The Swedish National Agency for Education, 2011, p. 9)

There is no school subject where those values are inscribed, but they are supposed to affect all education and all subjects. Research about general values in school subjects is called value research, but this is not the perspective of the WiFi-study. The objective of the WiFi study is to investigate what values guide students when deciding what is important when learning mathematics.

I began by giving an example from France to illustrate that mathematics education is not free from issues of culture and power. French educational authorities can align their choices more or less with values of French students. There is obviously a power relation concerning who gets to decide what is to be learned in the mathematics classrooms (see e.g. Popkewitz 2004, Skovsmose 2009, Guitérez 2010, Valero, 2004). A critical perspective on values and values research can help us explore and challenge those power relations.

Moving from qualitative data, as in Study 1 and 2 in The Third Wave Project, to quantitative data, as in the WiFi-project, imposed a need to describe the value-concept out of a perspective of measurements. Understanding and defining what values we wish to measure is also crucial for evaluating the validity and reliability of the questionnaire. The WiFi-study is based on value categories from different theoretical frameworks, Mathematical Values (Bishop, 1988) and Cultural Values (Hofstede, Hofstede & Minkov, 2010). The diversity of values has meant a need to differentiate amongst the many dimensions of values that are portrayed in the classroom. The aim of the WiFi-study is to learn about students’ values in mathematics learning. When adapting the questionnaire, it is crucial to conserve the metric equivalence, so that the target question measures the same value as the source question. A lot of effort is put into analysing the questions regarding values measured. This will be explained further in chapter 3.

Bishop (2012) concludes that values education should involve alternatives, choices, preferences and consistency. Values are what is to be valued, and the valuing is an act that includes choosing. 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 held by the individual or values found in 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.” This sociocultural perspective may imply that values should be regarded as something found in communities. However, surveys need to address individuals. Cultural values are shared by members of a cultural group (Hofstede, Hofstede & Minkov, 2010), hence found in a community and described by extensive research from a large sample. Measuring values held by an individual must be based on that individuals own description of his or her values, or by value indicators. To be able to discuss the measuring of those values by indicators, the characteristics of each value dimension with regard to surveying and measuring will be discussed.

1.2.1 Mathematical Values

The theoretical framework for the WiFi-study is the theory on Mathematical Values, developed and described by Alan Bishop. In 1988, Bishop published “Mathematical Enculturation”, where he used anthropological methods for investigating mathematics in different cultures, developing an anthropological theory on values to describe values in “western mathematics”.

Without being very specific about what a value is, Bishop (1988) outlines three dimensions of complementary value pairs:

- **Ideology**: Rationalism and Objectism
- **Sentiment**: Control and Progress
- **Sociology**: Openness and Mystery

Ideology concerns the ideals of mathematics, while Rationalism deals with the deductive reasoning, about proof and building an argument on stated axioms and definitions. In the example earlier, my French friend was valuing rationalism when he wanted Euclidian Geometry to be taught in the French school. Objectism concerns mathematics being dehumanized, dealing with stable mathematical objects like points or variables.

The sentiment-dimension is concerned with feelings and attitudes. Control is related to materialism and being able to predict and describe objects. Mathematical facts and algorithms can be understood, and real world phenomena, like planet movements, can be described by mathematics, which gives a feeling of security and control. Progress is a more dynamic feeling, related to development, choice and change/improvement. For example, an algorithm can be used in new situations and with new examples.

The sociology-dimension describes relationships between people, and between people and mathematics. Openness means that mathematical principles are regarded as universal truths, open for anyone to learn and use, so in that way, mathematics is democratic subject. Mystery describes mathematics as being an abstraction. There is a paradox that, even though mathematics is open and accessible, it is hard to tell what the origin of mathematics is, who invented it, what it is and what it is not.

The two values in each pair are complementary. For example, Rationalism and Objectism together tell us all there is to know about the Ideology value-dimension in mathematics. In Bishops theory, nobody is doing the valuing as mathematical values exist in the cultural context of western mathematics. These three dimensions are values that are typical for “western mathematics”, the mathematics taught through school and in university, based on the axiomatic systems.
1.2.2 Fostering and Power

Awareness about values in mathematics education can be used in two different ways. It can be used in an enculturation of students to make them members of the mathematical community, or it can be used for teachers or policymakers to be able to better align and adapt mathematics education to students’ values. To explore those possibilities, I present two different research perspectives regarding values in mathematics education. First, I discuss values in relation to enculturation, the fostering of students to be a part of a mathematical culture. Second, I discuss the role of values in emancipation and equity in power-relations in mathematics education.

The first perspective, values and mathematical enculturation, is first described by Bishop (1988). Mathematical values are within this perspective defined as “the deep affective qualities which education fosters through the school subject of mathematics” (Bishop, 1999, p. 2). Values being “deep” suggests that there is an unawareness of the values held by a person, or the values in one’s own culture. It is easier to see differences in values in a foreign culture, than to see the values in your own culture (Hofstede, Hofstede, & Minkov, 2010). When “education fosters” those values, there is an unawareness of possible alternatives. The fostering of mathematical values is part of learning mathematics, of entering a new culture. Values as the “core of culture” (Hofstede et al., 2010) are not easily transformed. Values held by an individual are stable, compared to beliefs and affections. To mathematics teachers and policymakers already being part of the cultural community of mathematics, the values are seen as the truth about mathematics.

The second perspective implies that the inculcating, or fostering, of values is a form of practicing power. Learning mathematics is regarded as participating in a discursive practice. The teacher or the policymakers behind curriculum has more power to decide on what is important to learn in mathematics than students do. Also within the group of students, some students are subordinated due to their cultural or societal background. The “socio-political turn” (Guitérez, 2010) in mathematics educational research proposes that mathematics itself needs to be deconstructed and examined, to pay attention to subordinated people in mathematics classrooms, and to question and examine what is normalized. Valero (2004) discusses the ambiguity of mathematics empowering people, when on the same time mathematics teaching can be an expression of imperialism and oppression. Mathematics has a symbolic power of general intellectual capacity in the “white, western world”, but this power only includes practitioners of “western” mathematics. Mathematics is used throughout all cultures, but often originating from practical needs, like counting or measuring, rather than philosophical axiomatic systems. Valero (2004) refers to Laves questioning of the Platonic ideal in mathematics.

What are the systems of values, that take part in the historical frames in which cognitive science developed, which made such a conception of knowledge ‘dominant’ —at the expense of contextualised, derived-from-practice knowing? What is it that makes particular kinds of school mathematics education practices develop in ways that are valued as the ‘right’ way of teaching and learning mathematics? What are the discourses, at different levels, which give teachers and students particular positions in those practices? How do students and teachers change —and in which direction their participation in those practices, and to the benefit of whose positioning do those changes happen? These new questions could guide us into investigations that reveal the fact that “learning mathematics” is a highly political and social act that needs to be understood in full connection within the multiple contexts in which that activity and practice unfolds.

(Valero, 2004, p. 12)
The claim is that there are “value systems”, resulting in the fact that decontextualized knowledge is more important than “derived-from-practice- knowing”. To understand whose value system affects the valuing of what is important, the power-relations in the mathematics classroom become relevant.

The fostering in school is by Popkewitz (2004) called the “Struggle for the Soul”. Mathematics education is part of the fabrication of a child, useful in society. In this process, there is a division between the normal child and others. The normal child is a child who can cope with the demands of mathematics education. This normality, to know mathematics, is supposed to be good for society. “Social goods are anything some people in a society want and value” (Gee, 2010, p 5), but “some people” have more influence and power than other people on what is to be learnt in the mathematics classroom. Valero (2003) problematizes the assumption that there is an “intrinsic goodness” in mathematics education, and an “intrinsic resonance” between mathematics, mathematics education and power. How can learning mathematics develop democratic values in students, or prevent students from for example becoming criminals? The resonance between learning mathematics and being useful in society is not necessarily a causal connection.

The “systems of values” mentioned in the quote above (Valero, 2004) can be different between nations or cultures, but they can also be different among different cultural groups within nations. Maybe they are different between different age-groups, like students and adults. Some values are important within western mathematics as well as in western society. Skovsmose (2009) discusses progress, neutrality and epistemic transparency as myths based in modernity, and suggests research beyond modernity, with a critique of rationality. Rationality, being a core mathematical value (Bishop, 1988), closely links mathematics education to modernity, and to participation in modern society. The social good then would be that as many students as possible achieve the ability to do mathematical, rational reasoning. At the same time, this is an excluding process. Students who will not align with this valuing of rationality will be excluded from full participation in the modern society.

It is not obvious that the fostering and the power perspectives can be separated. Inculcation of cultural meaning and values is part of participating in a discursive practice. Due to Fairclough (2010) this affects educational institutions, like schools:

Educational institutions are heavily involved in these general developments affecting language in its relation to power. First, educational practices themselves constitute a core domain of linguistic and discursive power and of the engineering of discursive practices. Much training in education is oriented to a significant degree towards the use and inculcation of particular discursive practices in educational organisations, more or less explicitly interpreted as an important facet of the inculcation of particular cultural meanings and values, social relationships and identities, and pedagogies.

(Fairclough, 2010, p. 532)

If much training is oriented towards the inculcation of discursive practices, and this inculcation includes cultural meanings and values, then it is of course important that those values are relevant for learning mathematics.

Changes in mathematics curriculum and its inscribed values often follow the societal development. Lundin (2008) outlines the history of Swedish mathematics education, where there were two curricula until 1968. There was one school attended by working class children, learning mathematics of use in their profession. There was a different school attended by bourgeois children, learning formalistic mathematics, where for example Euclidian Geometry had an important role. Even nowadays, after the school has been united for 45 years, there is still a struggle between the utilitarianism of mathematics and the academic view. A similar description of the historical development of mathematics education in Japan is made by Baba, Iwasaki, & Ueda (2012). They could relate the difference in values in the
ancient Japanese mathematics to the western mathematics now used to the historical and social
development in Japan (Baba et al., 2012). Within a national culture, there are several cultural sub-
groups (Hofstede, Hofstede & Minkov, 2010) with different sets of values. There are different ethnical
groups, but also different social groups. For example, English working class children more often
expect teachers to be more authoritative, while English middle class children more frequently raise
their hand and ask for explanations from the teacher. Students from cultural groups with values that do
not align well with the value systems of school can experience difficulties in understanding what is
valued as important when learning. Research shows that parents’ educational background is an
important factor for students’ achievement in school (OECD, 2010). This might partly be explained by
the different value systems in the different cultural groups. The chosen path for mathematics in school
will, more or less, include or exclude different categories of students. If mathematics is seen as a
merely academic subject, students from working class homes might be excluded, since they might not
value abstract reasoning. At the same time, making mathematics an applied subject might exclude
large numbers of students from pursuing academic studies in mathematics or engineering. Choices
made by educational authorities are based on valuing different perspectives of the subject of
mathematics. If there is a discrepancy between students’ values and the values in mathematics
education, what values are more important?

If we are convinced that values, for example mathematical values, are a social good, we need to foster
students according to those values. If school is expected to inculcate important values from society, to
prepare students to become good citizens, school need to foster students’ values. If we acknowledge
students’ values as being different within the population of students, school will need to adapt to
students’ different values. Measuring values in mathematics education thus can influence educational
practices towards improving equity in mathematics education.

The first sentence of the WiFi Research Guidelines (not published) is: “Education is key to a nation’s
social and economic development (UNESCO (n. d.)) contributing to her population’s sense of
wellbeing.”. Researching values can help us map and understand students’ values. If students are
allowed to express what they value in mathematics learning, and if teachers listen and align their
teaching, students are empowered to make reasonable choices in learning mathematics. Andersson
(2011) followed students identity narratives during a math project. Students were given the possibility
to choose contexts for learning based on their valuing of what is relevant and important. Andersson
(2011) could show that students agency changed, and engagement in mathematics learning improved.
In relation to the WiFi-study, learning about students’ values can allow us to shift the focus from what
curriculum or culture of mathematics education stipulates as “normal”, to what students value as
important in different cultural contexts.

If students’ mathematical knowledge is important for society, we need to consider all children as
normal. If school is to be successful in including children from different cultural and societal
backgrounds, an awareness of the differences in value systems is crucial. Mathematics is taught
globally. It obviously is or has been taught in different manners in different times and cultures.
Therefore, a relevant first step when teaching mathematics is to find out what students in this culture,
at this time, value as important in learning mathematics.

1.3 Measuring Values by Indicators

Can values held by an individual be measured? The problem can be compared to methodology of
attitude-surveys, where questionnaires use indicators of attitudes instead of posing direct questions
about attitudes (Sapsford, 2007). However, we must be aware that bringing methods of measurement into Values research implies a risk that the map we find might become repressive. Instead of describing values, research by indicators end up describing the indicators.

Sapsford (2007) problematizes what he calls the problem of reification. If we name and measure something, it exists. For example; Creating IQ-tests for measuring intelligence tends to change the meaning of intelligence to become the measure of the IQ-test. “Once the instrument exists, it will be taken as measuring something real and something useful” (Sapsford, 2007, p. 160). Sapsford (2007) also discusses the power of naming and describing phenomena. In describing what students find important in learning mathematics, and mapping our findings by the theoretical framework of values, we make an attempt to find causal connections that might have many different explanations. When measuring values, distinctions between indicators as phenomena in the “real world” are important to keep apart from values as being an ideational phenomenon within human culture. In the WiFi-study, activities from mathematics classrooms are used as indicators of students values, see also chapter 2.

I will compare how the word ”value” is used in the WiFi Research Guidelines (not published). First example: the first Research Question in the WiFi-study is “What values relating to mathematics and to mathematics learning are associated with students in Australia and in partner countries? “(WiFi Research Guidelines, not published, p. 8). Second example: ” Mathematics educational values, on the other hand, express the extent to which we value aspects of classroom norms and practices that relate to the teaching / learning of school mathematics.” In the first example, ”values” is a noun. In the second example, values is initially a noun, but later a verb, “…we value aspects…”(WiFi Research Guidelines, not published, p. 6). This double meaning of the word value in English language can be misleading. In the WiFi study, students are asked what they value (the verb), and in the research guideline the interpretation is that that what students value are values (the noun). To value something could mean to appreciate or like something, and that something is not often a value. I argue that, for example, to value problem solving does not make problem solving a value.

Summing up, attention must be paid to what is measured and how the result of measuring is interpreted. In the questionnaire, students are asked what they value as important in mathematics learning. When interpreting what students value as important, careful attention must be paid to not invent and reificate a concept that changes the intended meaning of respondents to the questionnaire.

### 1.4 Research Questions

Based on previous discussions, we need to problematize the methods of the WiFi-study. The WiFi-study focus values in mathematics education that affect students’ learning of mathematics. These values can be the mathematical values as described by Bishop (1988) and/or cultural values described by (Hofstede, Hofstede & Minkov, 2010). If cultural values affect what is learnt in mathematics, it is likely that mathematics teaching is different in different countries, and that pupils migrating to a new school system will encounter a new set of values. WiFi will explore the mathematics-educational values that are typical for each school system or nation, and the Swedish questionnaire will be used for value research in the context of Swedish mathematics education.

The aim of this thesis is to validate the translation and adaptation of the WiFi-questionnaire from English to Swedish. My objectives as stated in the WiFi Research Guidelines (not published) are to pay particular attention to four objectives. The first objective is to optimise the content validity, the extent to which the items represent the range of mathematical and mathematics educational values.
The second objective is to check against ambiguous and unclear items, to enhance the instrument reliability. The third objective is to optimise the metric equivalence of items, to ensure that the same concepts are being measured across cultures. The fourth objective is to optimise language validity by back translation.

I will in this thesis describe the translation and adaptation process from WiFi to VsV (Vad som är Viktigt\(^2\), the Swedish part of the study.). I will give a theoretical background to the value-concept in mathematics education. In this way I will be able to expand the validation of the questionnaire to include Construct Validity as well as Conclusion Validity. This calls for several methodological considerations, and the methodology of translation and adaptation of the questionnaire is my first research question.

When translating and adapting questions, issues of interpreting the responses arise. My objective is hence to raise important questions about how values can be measured out of student’s responses to the questionnaire. The questionnaire consists of different kinds of questions: multiple choice questions in section A, scaling questions in section B, an open response question in section C and background questions in section D. I will discuss the Construct Validity and problematize if the way of questioning is appropriate for measuring students’ values. The WiFi Research Guidelines (not published) suggest an interpretation of the questions in part A, where each question is supposed to indicate a certain value. I discuss the Conclusion Validity of this interpretation. Can the questionnaire measure students’ values? And if it cannot, what can it measure?

This leads to two research questions on survey methodology:

- What methodology helps us to best fulfil the objectives as stated in the WiFi Research Guidelines (not published)?
- In addition to the objectives stipulated by the main project, how can Construct and Conclusion Validity be improved?

The intention of this thesis is to problematize the measuring of the value concept. I hope to initiate a clarifying discussion among the participants of the international project. Those methodological issues have not been extensively described within the WiFi-project before, and describing them will allow other project participants to question and evaluate my results with regard to their own studies.

**2 Theoretical Background**

Methodology of translating and adapting surveys is an important framework for my thesis. I will here outline some principles used in this thesis. I will present and discuss a guideline for adaptation and translation of cross cultural surveys. I will also account for adaptations of these guidelines to fit the objectives of this thesis. Finally, some concepts from survey methodology of importance for analysis are discussed.

\(^2\) What I Find Important
2.1 Theory on Translation and Adaptation of International Surveys

The aim of translating this questionnaire is to keep equivalence of measurement across languages. The International Workshop of Comparative Survey Design and Implementation (CSDI) has conducted an extensive work at finding the best practice for cross cultural survey design. Results from this work has been published as web-based guidelines (Survey Research Center, 2010). Several publications comparing different methods for conducting Cross Cultural research are the source for describing the suggested best practice. I will use some of those reports as my framework and terminology for this thesis.

Harkness (in Harkness, Pennell, & Schoua-Glusberg, 2004) suggests not only a translation but an adaptation to target culture and language. This implies not only evaluating linguistic mistakes, but also to consider adaptation to the cultural context, to the intended group of respondents and to deal with generic problems from the source version.

2.1.1 Translation Approaches

When using a questionnaire in a new context or country, it needs to be translated but also adapted to the context. There are a few different approaches to translation, discussed by Harkness et al. (Harkness, Villar & Edwards, 2010). The different approaches discussed and compared are Machine Translation, Do-It-Yourself Ad-Hoc-Translation, Unwritten translation, Translation and Back Translation and Team Translation. To give a brief description of those different approaches: A Machine Translation reduces human involvement, but is not a good choice when the goal is to keep the intended meaning of the questions. Do-It-Yourself Ad-Hoc Translations stipulate that anyone who knows the two languages can make a translation, but the translator also need good knowledge about posing good questions and developing questionnaires, knowledge that a trained translator will have. Unwritten translations are used in interviews, where the interviewer translates the source questions “on spot”, or the translation is made by an interpreter when conducting the interview. Translation and back translation is conducted to investigate problems in the target text, the back translation is compared to the source text. This produces limited information of the quality of the target text. Harkness et al. (2010) criticizes the use of Back-Translation as a standard method, and draws on research that shows that appraisal of the target text directly is more valuable.

Harkness et al. (2004) suggests Team Translation as the current best practice. A team should include translator, reviewer and adjudicator. Adjudication is suggested to follow these steps: linguistic mistakes in the translation process, cultural adaptation problems, questions that won’t work in the intended group, generic problems from the source version. These perspectives are explained and used in the different steps of the translation process in the Methodology-chapter. In each step, there are many choices to be made. For our project, translating the WiFi-questionnaire, we have adopted the Team Translation method. How it has been adapted is further described in depth in the methodology chapter.

2.1.2 Survey Translation Forms and Terminology

Harkness et al. (2010) outlines some important forms and terminology for the translation of surveys. The original text is called the source text, its language source language, and the translated text will be called the target text. In this thesis, the source language of the source questionnaire is English, and the target language is Swedish.
A translation can be transparent or covert. A covert translation does not signal that it is a translation, it is domesticized. A word-for-word translation follows the sentence structure of the source language, and will not likely be covert. A Conceptual Translation is sometimes used to describe a translation that operates on the level of words. The term Literal Translation is sometimes used, often about texts with a focus on information. A close translation meets the requirements regarding vocabulary, idiom and sentence structure but tries to remain close to the semantic import. A “Too Close Translation” will disregard normal usage in the target language. Direct Translations has some different explanations, it can be understood as a Close Translation, or a translation that has the same flavour and characteristics as the source text.

An Idiomatic Translation uses idiomatic phrases in the target language, but it also uses the most familiar expression in the target language instead of a word-for-word translation. This will be a more covert translation. An Adaptation is intended to “tailor questions better to the needs of a given audience but still retain the stimulus or measurement properties of the source.” (Harkness, Villar, & Edwards, 2010, p. 122). Translation is interlingual, but adaptation is interlingual or intralingual, it can be used to tailor texts within the same language to match respondent needs. The translation of the WiFi-questionnaire needs to be adapted to Swedish culture, but also to the intended group of respondents.

Different forms of adaptations to cultural context are necessary (Survey Research Center, 2010). The intended meaning of the questions needs to be what the respondents understand, so we need to consider cultural and semantic effects. These are the adaptations suggested:

- System-driven adaptation, for example the need to change from Farenheit to Celcius, or other units of measurement.
- Adaptation to improve or guide comprehension, to concretize, can be needed. In the VsV questionnaire, we gave examples to concretize some activities suggested, when they are not very common in Swedish mathematics education.
- Adaptation to improve conceptual coverage, to be obtained by giving examples relevant to the respondent.
- Adaptation related to cultural discourse norms, regarding for example politeness or status.
- Adaptation and cultural sensibilities, to be aware of cultural norms and taboos. To the VsV-questionnaire, this became important when dealing with the background questions in Section D.
- Adapting design components or characteristics as the direction language is written in or the meaning of symbolic representations. Since both Sweden and Australia are part of “Western cultures”, and English uses the same alphabetic symbols, this did not arise.
- Adaptation related to lexicon and grammar, as in response categories. This was considered on several levels in the VsV-questionnaire, and is described in the Results-chapter.
- Adaptation to maintain or to reduce level of difficulty depending on the goal of the study, to compare how well respondents perform or to compare opinions, behaviours and attitudes. This was considered in VsV with regard to what eleven-year old students would understand, and with regard to known content due to Swedish mathematics curriculum.

Not all were used, and I have commented above on the adaptations we needed to use, and briefly how we used them in our translation process. This theory on adapting and translating surveys was relevant
when considering different possibilities and choices in the translation process. We choose the adaptations that could help respondents answer to the intended meaning of each question.

2.2 Surveying Values

Surveying complex concepts like values will not allow us to use factual questions, (questions like “Do you value Rationalism as Important when learning mathematics?). Surveying values can be compared to surveying attitudes. To measure attitudes, there is a need to use indicators (Bryman 2012, Sapsford, 2007). Analogously, valuing learning the proofs can be an indicator of the value of Rationalism.

The questionnaire consists of four sections (Appendix 1), with different types of questions that requires different kinds of analysis:

Section A, uses indicators, activities from the classroom, respondents fill in a checkbox for how important it is, and a Likert-scale is used for the analysis, where “Absolutely Important” gets the value 5, and “Not important” get the value 1.

Section B consists of pairs of mathematics educational activities, and students are asked to put a tic close to the activity they prefer. No method of analysis had been suggested for this part.

2.2.1 Historical, Societal and Cultural Background of Swedish Mathematics Education

To determine what value a value indicator indicates we must know about societal and historical facts that form mathematics educational practices.

The Swedish School Inspectorate (2009) made an assessment on mathematics teaching in Sweden. It concluded that Swedish teachers were still relying on the textbook when teaching mathematics. Instead of relying on the curriculum, they trust the textbook to address the mathematics needed. As a result, the practising of calculation procedures and getting the right answer are often the focus of mathematics teaching.

How historical and societal development influences mathematics educational practices is discussed by Lundin (2008). When Swedish schools were made public and mandatory in 1842, teachers had to deal with a large number of children that were the first generation attending school. Mathematics was used as a medium for fostering children. When schoolbooks first were developed, they did not only have the objective to support the learning of mathematics, they also needed to help the teacher to cope with disciplinary problems in classrooms. “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.” (Lundin, 2008, p.376).

The historical and societal development can explain the result of the evaluations by the School Inspectorate (2009). 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. It is likely that both parents and students expect mathematics education to be conducted this way, and it has become a part of the culture of mathematics education in Sweden. Activities in mathematics are likely to be valued out of the Swedish cultural context.
2.2.2 Cultural Values

A framework for describing the relative nature of values has been developed by Hofstede, Hofstede and Minkov in “Cultures and organizations: Software of the mind” (2010). Both the concepts of culture and values are given explicit descriptions and definitions by Hofstede et al. They write: “Culture consists of the unwritten rules of the social game. It is the collective programming of the mind that distinguishes the members of one group or category of people from others.” (Hofstede, Hofstede & Minkov, 2010, p. 6). To be able to compare what values that distinguishes a cultures from another, Hofstede et al. (2010) developed indexes for different value dimensions.

Hofstede et al. (2010) uses a dimensional index scale, where they indexes value dimension out of several questions. This is an example of the collectivist – individualist dimension:

![Figure 1: Three examples on how nations are distributed on the Collectivist – Individualist index scale](image)

The dimensional nature of values is described as: “Values are feelings with an added arrow indicating a plus and a minus side” (Hofstede et al., 2010, p. 9). It is suggested that values come in pairs like good - evil, rational - irrational, beautiful - ugly. If Individualist comes with a minus sign, we get collectivist and vice versa. Hence, Individualism and collectivism are opposites. It is also a continuous index-scale, where a nation can be ranked as more or less individualist or collectivist.

Values are by Hofstede et al. (2010) defined as “the core of culture”. Culture reproduces itself, by values being transmitted by i.e. parents and education. This transmission takes place in cultural practices, the visible parts of culture. Those practices can be what parents say when they foster their children, or what activities teachers choose in the classroom. How those practices are interpreted, their cultural meaning, is decided by the members of the cultural group. For example, a student calling a teacher by his/her first name is seen as friendly in Sweden, but disrespectful in France. It is by Hofstede et al (2010) discussed if educational systems can inculcate new values, change values or reinforce already existing societal values. Their conclusion is that the teacher-student interaction resembles parent-child interaction. This way, school often reinforce values already existing in society.

Based on data from a large international study on IBM-employees, Hofstede et al.(2010) indexes six different cultural value dimensions. This index was not achieved by measuring values directly, however, Hofstede et al. (2010) used measures of visible cultural practices. The measurements were combined and developed to an index of a value dimension. In the mathematics classroom, the visible cultural practices are the activities conducted by teachers and students. I will in Chapter 5 discuss whether those activities can be used as indicators of cultural values.

These are the six cultural value dimensions described:

1. Power distance
2. Individualism-collectivism
3. Femininity-Masculinity
4. Uncertainty Avoidance
5. Long term orientation
6. Indulgence - Restraint

This is a developing theory, and the two last dimensions were added recently. The four first dimensions are the ones described in the WiFi Research Guidelines (not published). An indexed scale was developed by Hofstede et al. (2010) to compare nations out of the above described value dimensions. Implications for different areas in society were discussed, and below I refer the suggested implications for school and education, since those values also have an implication on values in mathematics learning.

The first dimension, Power-distance, indicates a dependence on authorities, like leaders or teachers. Low Power-distance indicates the. In Swedish culture there is according to Hofstede et al. (2010) a low power-distance. One example that might indicate difference in power-distance is how pupils address their teachers. France has a higher power-distance index than Sweden, and in France, children are expected to politely address their teacher as “monsieur” or “madame” followed by the teachers’ last name. In Sweden, pupils address their teachers by their first names.

Table 1: Power Distance in societies and consequences for education

<table>
<thead>
<tr>
<th>Low Power Distance</th>
<th>High Power Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>• expectation of equal distribution of power</td>
<td>• teachers outline the intellectual path to be followed</td>
</tr>
<tr>
<td>• teachers are expected to treat students as basic equals</td>
<td>• students speak up when they are asked to</td>
</tr>
<tr>
<td>• students are expected to ask clarifying questions and to intervene uninvited.</td>
<td></td>
</tr>
<tr>
<td>• learning depends on a working two-way communication between students and teachers</td>
<td>• students are expected to follow teachers’ instructions.</td>
</tr>
<tr>
<td></td>
<td>• learning is about truths or facts where the teachers are regarded as “gurus”</td>
</tr>
</tbody>
</table>

Working class families often have a large Power-distance subculture. Therefore competent working class children can suffer a disadvantage, since he or she cannot understand what is expected in school. (Hofstede et al., 2010).

The second dimension, collectivism and individualism, describes the degree of how much the interest of the group prevails over the interest of the individual (Hofstede et al, 2010). Sweden has, according to Hofstede et al (2010) a high individualist index. The motives for achievement in the two different groups are very different.

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3 “Sir” or “madam”
Table 2: Collectivist or Individualist societies and consequences for education.

<table>
<thead>
<tr>
<th>Collectivist</th>
<th>Individualist</th>
</tr>
</thead>
<tbody>
<tr>
<td>• students wait for the approval of the group and will only answer a question when asked directly</td>
<td>• students are supposed to speak up in class</td>
</tr>
<tr>
<td>• students from collectivist societies are likely to form in ethnic subgroups in class</td>
<td>• individuals form groups ad hoc</td>
</tr>
<tr>
<td>• avoidance of shame is important</td>
<td>• education stresses how to learn</td>
</tr>
<tr>
<td>• stresses learning abilities applicable for society</td>
<td>• a diploma improves self-respect.</td>
</tr>
<tr>
<td>• diplomas honours the group and the owner and give access to higher status groups</td>
<td></td>
</tr>
</tbody>
</table>

The third dimension, The Femininity-Masculinity index, correlates with gender equality. However, in the value dimension of masculinity values like competiveness and challenge are held by men, and feminine values like security and modesty are held by women. In a feminine society, gender roles overlap. A better name to understand what this dimension relates to could be *gender-role-distance*, analogue to power-distance. Sweden has the highest feminine-index.

Table 3 Feminine or masculine societies and consequences for education

<table>
<thead>
<tr>
<th>Feminine</th>
<th>Masculine</th>
</tr>
</thead>
<tbody>
<tr>
<td>• being an average student is the norm</td>
<td>• the best student is the norm</td>
</tr>
<tr>
<td>• the “Law of Jante” calls for jealousy of those who excel</td>
<td>• competition in class and in sports is important and failing in school is a disaster</td>
</tr>
<tr>
<td>• children are socialized to be nonaggressive</td>
<td>• students overrate themselves</td>
</tr>
<tr>
<td>• friendliness in teachers is appreciated</td>
<td>• aggressions by children are accepted</td>
</tr>
<tr>
<td></td>
<td>• brilliance in teachers is admired.</td>
</tr>
</tbody>
</table>

The fourth dimension, Uncertainty avoidance, is a dimension that describes avoiding situations that are new or different, and appreciation of what is predictable. Sweden has a low Uncertainty-avoidance-index.

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4 Law of Jante is mentioned by Hofstede et al. (2010), but originally formulated by Aksel Sandemose in “A fugitive crosses his tracks” in 1933. There are ten rules, and the first rule says “You’re not to think you are anything special”. 

14
Table 4: Uncertainty-avoidance in societies and consequences for education

<table>
<thead>
<tr>
<th>Low Uncertainty-avoidance</th>
<th>High Uncertainty-avoidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>• students are comfortable with open ended questions</td>
<td>• students are comfortable in structured learning situations</td>
</tr>
<tr>
<td>• teachers can say “I don’t know”</td>
<td>• teachers are supposed to have all the answers</td>
</tr>
<tr>
<td>• results are attributed to a person’s own ability.</td>
<td>• results are attributed to circumstances or luck.</td>
</tr>
</tbody>
</table>

The fifth value dimension is developed later from a Chinese value survey, and it describes long term orientation. Here, Sweden is indexed in the middle. In a short-term-orientation society, students attribute success and failure to luck. In long-term-orientation societies, students attribute success to effort, and have better results in mathematics, and a talent for applied, concrete science.

The sixth dimension, named Indulgence and Restraint, comes from The World Value Study on Subjective Well-Being, or happiness (Hofstede et al., 2010). This index deals with the emotion of happiness, life control and the importance of leisure. Sweden is ranked as indulgent, as number 8 on the scale. This chapter (Hofstede et al., 2010) does not discuss implications for education, and is not discussed in the WiFi Research Guidelines (not published). However, it might be an interesting value dimension to add to this study. If it is true that Swedish students value indulgence and avoid restraint, it can affect their valuing of activities when learning mathematics. For example, they might value mathematical activities that include a degree of openness.

According to Hofstede et al. (2010), cultural values affect what student’s value in education. It is therefore likely that the cultural values described above will affect what student's value when learning mathematics.

2.2.3 Measuring Mathematical Values

To be able to measure values, we first need to establish the properties of the concept we wish to measure. To be able to compare measurements between participating countries, we have to establish variables to compare. Bishop (1988) describes the mathematical value dimensions as pairs of complementary values. I will outline and discuss some properties of such complementary pairs.

Example 1: In the set of ideological values, rationalism and objectivism are said to be complementary. This implies that if an ideological value is not a value of rationalism, then it is a value of objectivism and vice versa. This can be illustrated with set theory:
Example 2: A value probably can be either Rationalism or Objectism. From my understanding, this is not equivalent to saying that a person cannot at the same time value Rationalism and Objectism. If asked, I think most of us would say that Rationalism and Objectism both are very important in mathematics. This will give us this scheme:

As Bishop describes the dimensions of mathematical values, they are complementary. A mathematical value cannot at the same time be a value of Objectism and a value of Rationalism. However, if an individual is doing the valuing of a mathematical activity, I argue that this person combines different values in deciding if the activity is important or not. For example, let us look at an analysis of the activity of proving that in a triangle, the sum of angles is 180 degrees. It can be important because the individual value Objectism, learning more about the properties of the object of triangles. At the same time, it can be valued as important because the individual value the Rationalism of proofs. So when students’ valuing is measured, value dimensions can overlap, they are no longer complementary.

I argue that measuring sets of complementary values is different from measuring sets of overlapping values, as will be discussed later in chapter 4.

2.2.4 Measuring Mathematics Educational Values

In addition to Mathematical Values and Cultural Values, The Third Wave Project investigates what the Mathematics Educational Values are. Students Mathematics Educational Values are also described
in the WiFi Research Guidelines (not published). Mathematics Educational Values have earlier been researched in The Third Wave Project in Study 1 and 2. WiFi, Study 3, draws on results from mainly Study 1. 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 mathematical activities pictured were analysed, several items that students found important for learning mathematics were categorized.

From categorizing mathematical activities, for example pictures taken on/in different activities (Seah & Peng, 2012; Dede, 2011; Lim, 2010), six mathematics educational value dimensions are derived (presented in the WiFi Research Guidelines, not published):

- Pleasure/effort
- Process/product
- Application/computation
- Facts and theories/ideas and practice
- Exposition/Exploration
- Recalling/Creating

These values are to be regarded as dimensional due to the WiFi Research Guidelines (not Published). Each value in a pair of values is an extreme, and should be measured along a continuum.

However, compared to the Cultural Value Dimensions (Hofstede, Hofstede, & Minkov, 2010) the nature of mathematics educational values is different. If pleasure is taken “with a minus sign”, you get boredom, not effort. Pleasure is not an opposite of effort. Analogously, the opposite of recalling is forgetting, not creating. These value dimensions are not extremes of the same scale.

In the Mathematics Educational Values-theory, I miss the labelling of each dimension. What do for example recalling and creating have in common, and when are they seen as opposites? Bishop (1988) as well as Hofstede et al (2010) adds a name on the whole set, for example Openness and Mystery is called the sociology-dimension. It is not transparent why the Mathematics Educational Values are paired the way they are, and what connects the values in each pair.

The WiFi-study will be part of building a theory on mathematics educational values. My reflection is that some of those suggested Mathematics Educational Values resembles cultural practices, rather than values. This can be a matter of choosing appropriate categories, and the quantitative WiFi-study can help explore and develop the categorization of Mathematics Educational Values.

### 2.2.5 Question Types

For us to understand how the questionnaire can be translated, we need to understand the construction of question types. Different question types lead to different data, and will affect what can be concluded.

Section A consists of questions on activities from mathematics classrooms. Those activities are intended as value indicators, as previously discussed. Students choose from alternatives from “Absolutely Not Important” to “Absolutely Important”, and data can be coded by a Likert-scale. This allows a statistical analysis and comparisons of data between countries, if translation is well performed.

Section B consists of pairs, connected by a scale.
One example:

<table>
<thead>
<tr>
<th>How the answer to a problem is obtained</th>
<th>What the answer to a problem is</th>
</tr>
</thead>
<tbody>
<tr>
<td>___ ___ ___ ___ ___ ___ ___ ___ ___ ___</td>
<td>___ ___ ___ ___ ___ ___ ___ ___</td>
</tr>
</tbody>
</table>

Students can value one or the other, or both as equally important, by putting a mark on the line. The question type resembles Semantic Differentials (Sapsford, 2007). Due to Sapsford, two opposed adjectives are used to obtain a semantic differential (Cold – Hot, Tall – Short). In WiFi, instead two activities are suggested. Activities are not opposites in the same way as opposed adjectives.

It is also hard to find a scale connecting the two activities. While there is a temperature scale connecting cold and hot, and a length-scale connecting tall-short, it is unclear what scale is connecting the two activities in the example above. Therefore it is not certain that Section B shall be interpreted as Semantic Differences. I have not found a question type that better corresponds to the construct design of Section B. In Chapter 4 I will discuss how this will affect the analysis of Section B.

Section C consists of an open question. Students are asked to suggest ingredients to a “magic pill” that contains what you need to learn mathematics. Responses from question C will need to be analysed with qualitative methods. Alternatively, they can be manually coded for a quantitative analysis. If countries shall be able to compare results from Section C, we need to agree on a coding procedure to be shared in the project.

Section D consists of background questions, asking questions relevant to learn about respondents societal and cultural background.

Understanding the choice of construct and design allows us to understand how the questionnaire can be analysed. It is thereby also important in the translation process.

3 Methodology

My first research question calls for a methodology of translation and adaptation of international surveys, and my second research question calls for a methodology of analysing respondents intentions when answering the questionnaire, as well as a methodology for measuring values. In this section I will describe the methodology for investigating my research questions.

The translation and adaptation of the questionnaire is discussed mainly from the translation and adaptation of the first part of the questionnaire, Section A. The second part, Section B was problematic to deal with, and we are not content with our translation. The translation process of Section B will not be extensively discussed, and the reasons for that will be explained later in this chapter. Section B will therefore be discussed mainly out of research question 2, how the nature of values affects the methods of questioning.

Section C is an open question, students are asked to propose ingredients for a magic pill that will make someone who takes the pill good at mathematics. Section D consists of background questions. The translation and adaptation of those two parts was rather unproblematic, and will not be deeply explored.
In this chapter, my first research question will be investigated based on results of translating and adapting Section A, and my second research question is discussed based on an analysis of Section B together with Section A.

3.1 Translation and Adaptation

To fulfil our objectives in the project and answer my first research question, we mainly used and adapted Harkness framework for translating and adapting international surveys (Harkness, Pennell, & Schoua-Glusberg, 2004). Harkness et al describes four stages in the translation process. We needed to add stage zero and stage five in order to better understand the items used in the questionnaire.

3.1.1 Methods of Validating Content Validity and Metric Equivalence

In this section, I discuss two objectives described in the WiFi Research Guidelines, the content validity and metric equivalence. Our first objective in the project was to optimize content validity, which was to investigate the extent to which the items in the questionnaire represent the range of mathematical and mathematics educational values. We needed to find out if there was something missing in the questionnaire that Swedish students find important in mathematics learning. The next objective was to investigate the metric equivalence of items in the questionnaire. That implied a need for investigating if the value indicators relates to the suggested values.

We wanted to find out if items are missing in the questionnaire (content validity), and help us use students’ own words in our translation (adaptation to the intended age group). I chose to use a method of short semi-structured scoping interviews. Semi-structured interviews consist of some pre-planned themes or questions, followed up by scoping questions (Bryman, 2012). Interviews also helped us discuss the metric equivalence by asking students why they value different activities.

I interviewed eleven Swedish students, ten to fifteen-years old. Our purpose was to investigate the correspondences between indicators and values in the Swedish context. Since values vary between cultures, we needed to try to ensure that an indicator in a Swedish context indicates the same value as in an Asian/Australian context.

Stage zero: The considerations I made for choosing my sample of students for interviews were to get students from the intended age group (eleven to fifteen years) and to get a mix of boys and girls with variations of ethnic, language and social background of the students. Students were chosen among children from the same area, but from different schools, public as well as private. Out of eleven students, there were five boys and six girls, some have both Swedish parents, some have one or two parents not born in Sweden, some have parents with academic exams, and some have parents with shorter education background. For being a sample of eleven students, the mix is satisfactory.

Before the translation process started, scoping interviews were conducted. The students were asked to elaborate on two open questions:

1. “What do you find important when learning mathematics?”
2. “How would you design maths lessons if you were to decide yourself?”

Interviews in Stage zero were conducted at student’s home (three interviews) or in school (eight interviews) by me alone. The interviews were semi structured (Bryman, 2012). My two questions were to be followed up by direct questions or probing questions. Students interviewed at their home had parents present. The interviews were recorded and later transcribed. Names were coded.
The purpose for the transcription in my research was to be able to compare student’s answers to questions in the survey. Transcription can focus different aspects and be performed at different levels, due to the intended use (Bryman, 2012). The method of transcription I chose was to keep the transcript readable, therefore rules for spelling words as in written language was used. I marked when two participants spoke simultaneously, and I marked pauses and laughter. No body language or gesture is marked in the transcript.

From the transcripts I first looked for activities that could be value indicators. Second, if the same activity already existed in Section A of the questionnaire, they were coded with the number of that question. A spreadsheet was used to keep track of what questions was used in the questionnaire. Activities found in transcripts that did not exist in the questionnaire were added to the spreadsheet. Third, this analysis was used for different purposes: to check if items were missing in the questionnaire (content validity), to analyse metric equivalence by comparing with the suggested interpretation in the research guidelines, to help use students wording and examples in our translation and to facilitate the understanding of the questions.

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, two items in the interview answer were activities from mathematics education, and hence regarded as value indicators: “calculate in my textbook” and “do homework”.

Second, the correspondence between the student’s interview answers and the questions in the questionnaire was analysed. To give some examples:

Question 57 in the WIFI-questionnaire says “Homework”, so there was 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”.

So for the content validity, I concluded that this answer was well enough covered by Question 57 and 36 in the questionnaire, this was not a new indicator or an expression of a value that was not covered by the questionnaire.

Third, I investigated the metric equivalence by analysing if the value indicators expressed by students could be found to indicate the same values as suggested in the WiFi Research Guidelines (not published). In the research guidelines, each activity in the questionnaire is associated to one or two values, they are meant to be value indicators. The questions that appeared most frequently in the interviews were chosen for this analysis. Value indicators expressed by students were compared to all three value categories (mathematical values, mathematics educational values and cultural values) and the underlying value dimensions. In this analysis process, motivations expressed in interviews by the students were used, as well the theoretical frameworks described for values and research about traits in Swedish mathematics education.
3.1.2 Methods of Validating Language validity, Instrument Reliability, Cultural Meaningfulness and Metric Equivalence again

We saw that the back translation was not enough to validate all four objectives above. Therefore, we adopted the Team Translation Process (Harkness, Pennell, & Schoua-Glusberg, 2004), as described in chapter 2. We made some adaptations to fit our resources and our project. This process involves a translator, a reviewer and an adjudicator, and the stages are described below.

**Stage one:** In this stage, the translator suggests a translation of the questionnaire, which is reviewed. Me, Lisa Österling, and Anette De Ron had the roles as translators, but we translated different parts of the questionnaire. We reviewed each other’s translations, and held adjudication meetings to decide on the best translation.

**Stage two:** We had two sessions to discuss the translations, so the adjudication was a team work with Annica Andersson, Lisa and Anette involved. Most effort was put into part A, the multiple-choice-questions since we had some suggestions from Stage zero. We focused at this stage to keep the translation as close to the original version as possible. We looked up items in the curriculum, to check for the meaningfulness of proposed activities in a Swedish context.

**Stage three:** The back translation from Swedish to English was suggested as an evaluation of language validity from the WiFi Research Guidelines (not published). The back translation was made by Elisabeth Hector and David Hector. They had not previously seen the questionnaire. I compared Section A from the back translated questionnaire to Section A in the source questionnaire. I colour coded the translated questions, where green was used for questions where green was used for exact similarity, blue for kept meaning of sentence, orange for slightly different meaning and red for changed meaning. The back translation was similar enough to the original version, see chapter 4 for an analysis.

**Stage four:** In our process, we decided to conduct a pilot test of the questionnaire amongst students, followed up by interviews to evaluate the instrument reliability, cultural meaningfulness and again the metric equivalence. This was a teamwork between Charlotta Billing and Lisa Österling.

The sample for the pilot test was a class of 27 eleven-year old students, thirteen girls and fourteen boys. Three children had parents born outside the EU. This class was in a public school in a middle-class suburban area of Stockholm, as far as we can tell a very “normal” class from our research perspective. We chose eleven-year-old students, because we wanted to see if they understood the questions in the questionnaire. We assume that if eleven-year old students understand the questions, fifteen-year old students will understand them too.

The pilot test was conducted in class, and we could use 30 minutes of a mathematics lesson. The students were informed of the purpose of the VsV-study, and that their participation was voluntary. In this time, they all were able to fill out Section A in a paper version of the questionnaire. Since the whole group did not have time to finish, we used our results for section A in our analysis. The students were asked to mark questions they found hard to understand (language validity and cultural meaningfulness). This result was used to reconsider our translations.

To analyse data from the pilot test, I counted the number of students who marked a question in Section A as difficult to understand. This data was inscribed together with the back translation in the spreadsheet. An example from this spreadsheet can be seen in chapter 5.3.

The quantitative pilot test was combined with interviews. The result of the pilot test was used to plan the semi-structured interviews to be held with students. Those semi structured interviews had three
questions planned in advance, and they were conducted by me and Charlotta Billing. The interviews were conducted at the home of one of the students participating.

The intention for the Pilot test was to learn more about two aspects: how students interpret the questions and how they would describe or concretize the learning activities suggested in the questionnaire (metric equivalence). We used the Likert-scale (Bryman, 2009) to analyse answers to part A, where “Not Important” got the value 1 and “Absolutely Important” got the (numerical) value 5. We used Excel to colour code the most common answers. We could not deal with all the questions in an interview. Instead we chose the questions the students had indicated to value as most important in the pilot, which was question 5, 14, 28 and 51, and questions with a significant difference amongst student’s answers (question 36, 37, 39, 44, 45).

We looked for similarities in those questions, and we were able to formulate three themes instead of nine questions.

- Practicing a lot (Q36, 37)
- Looking for mathematics in real life (Q10, 12, 39)
- Feedback or metacognition (Q44, 45, 51)

At this interview, different kind of questions were asked (Kvale & Brinkmann, 2009): direct questions as “What do you do to learn something new?”, probing questions as “What do you do when you practice?” or interpreting questions as “So you say it depends on what kind of mathematics you are learning?”. The interviews were recorded and transcribed. The transcript was used to compare students’ answers to the questions of the questionnaire (Section A). Examples of this analysis are found in the Results-chapter. The team could then conclude that we needed another approach for the translation of part A. The main reasons for this decision were that respondents in the pilot-test did not understand the questions. There were no significant lingvistic mistakes, however, we had to consider the cultural adaptation and, even more important, adaptation to the group.

3.1.3 New Translation Considerations

The result from our pilot test showed that our first translation still had problems with adaptations to the intended group, students could not understand all questions. When the aim was to perform a translation that could pass a back translation, it was not enough adopted to culture and the intended group. Therefore, we made some changes in our strategies for translations and adaptations.

**Stage five:** Anette De Ron, Annica Andersson and I had a new translation session, where we worked on finding expressions and concepts from Swedish classroom contexts. We used our years of experiences as teachers and teacher educators to find the best expressions that could fit classroom cultures and the selected age group of the respondents. Cultural taboos also made us exclude questions about ethnicity in part D.

At this stage, the team used all information we had gathered to reconsider our translation and adaptation of section A. We used results from the Pilot Test, from the analysis of curriculum5 and from the back translation.

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5 *This analysis will be discussed in depth in further publications by Anette De Ron.*
We also needed to consider the generic problems. The questions in part A were grammatically different, sometimes one single word, sometimes a full phrase. We decided that every question should be a statement in the form of a full phrase, with at least one noun and one active verb, to facilitate the students’ reading and understanding of the questions.

The translation of section B was in focus for the next translation session. This time Lisa Österling together with Elisabeth Hector was the translation team. We found it hard and not transparent how to formulate the questions as value indicators, to formulate questions that will not be misinterpreted and to understand how an analysis can be made. This section had been neglected in earlier analyses, and its validity was not enough analysed and discussed. The questions in section B are different from questions in section A, and calls for another discussion. This discussion is found in chapter 3.2.2.

3.2 Construct and Conclusion Validity

Construct Validity explains how the questionnaire is designed and constructed to best measure the intended items. Conclusion Validity is about how reasonable and valid the conclusions drawn from data are.

The different frameworks, Mathematical Values, Cultural Values and Mathematics Educational Values, assign different properties to the value concept as we have seen in chapter 2.4. To be able to evaluate the measuring of students’ values, my second research question implies different methodological considerations depending on the nature of the different value concepts. For the purpose of discussing what is measured by the questionnaire, I again used my qualitative data from interviews, together with earlier research on what is known about traits in mathematics teaching in Sweden, and theories about values, discussed in chapter 2.

Items I could find in both interviews and in the questionnaire were chosen. This way, I could perform a triangulation of methods. I analysed the items out of all possible value dimensions to be able to discuss what value it is, I used the explanations found in interviews with students, and compared to the suggested interpretation in the WiFi Research Guidelines (not published).

3.2.1 Method of Analysing Values as Measurable Variables: Construct Validity

A variable can be used for assigning a measure to an item (Sapsford, 2007). To be able to treat data quantitatively, this variable needs to be assigned to a scale. There are a few choices on what is to be regarded as a variable in the analysis of responses from the questionnaire.

One choice is to let Importance be the variable measured. Importance will be a dependent variable, depending on students’ values. This means, a value held by a student will affect how important this student find a certain question or activity. In section A, the variable of Importance can be measured by a Likert Scale. This analysis might be disturbed by extraneous variables (Sapsford, 2007). For example, a respondent can value homework as not important just because he or she does not appreciate homework, even though it is important for learning mathematics content. Here, it is not unlikely that students’ experiences, attitudes and affections also affect students valuing of the importance, not just their values. Therefore, a direct analysis of students’ answers to what they find important can only say something of the variable of importance.

A large data set can be used to statistically find patterns that can lead to derive underlying values. To be able to use measures to describe values from variables in statistical analysis, we need to establish
the nature of the item we measure. As discussed in chapter 2, values are different in character. Hence, different kinds of questions are needed in order to measure them accurately. In Section A, they are all measured by indicators and the variable of importance. In Section B, the questions consist of two opposed activities. The question type resembles questions of Semantic Differentials. That is when a respondent put a check on a line between two opposed adjectives (e. g. hot______cold) (Sapsford, 2007). I will discuss this from an example:

Question 66 is about mathematics educational values. The instruction given to students is:

For each pair of phrases below, mark on the line segment to indicate how more important one phrase is to you in your maths learning than the other phrase.

If you mark in the middle, it would mean that both phrases are equally important to you.

(English Source Questionnaire, Appendix 1)

Q66:

<table>
<thead>
<tr>
<th>How the answer to a problem is obtained</th>
<th>What the answer to a problem is</th>
</tr>
</thead>
<tbody>
<tr>
<td>___ ___ ___ ___ ___</td>
<td>___ ___ ___ ___ ___</td>
</tr>
</tbody>
</table>

Semantic Differentials can be measured in two different ways, either by assigning one extreme as 5 and the other 1 (like the Likert Scale), or by regarding the middle value as neither hot nor cold, and assign it the value 0, while both extremes get the value 2. I will in chapter 4 discuss whether these questions can be treated as Semantic Differences.

For us to understand how Section B can be translated, we need to understand how it can be interpreted and analysed. To do this, I have analysed the data level of variables used as measures. I have also analysed what scale that is possible for measuring the variables. I will in chapter 4 describe this analysis and the use of the nature of values as described in chapter 2 to problematize the Construct and Conclusion Validity of Section B.

Summing up, variables are introduced for being able to measure what students’ value. The type of question chosen need to be adapted to the nature of the variable, and hence to the value we intend to measure.

3.2.2 Value Indicators: Conclusion Validity of Section A

The use of indicators in the WiFi-study has previously been discussed by Andersson & Österling (2013). In WiFi, the three values categories (mathematical values, mathematical educational values and cultural values) all have sub-dimensions of values, and the study uses a set of 24 different values. Children responding to the questionnaire cannot be expected to relate directly to a value; hence, the posed questions are about different learning activities, regarded as value indicators. In WiFi, the indicators are analysed within three categories of values. In every category, there are several value dimensions. Figure 4 shows how a learning activity can be a value indicator of one or sometimes two certain values.
An example of how Figure 4 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 (Hofstede, Hofstede, & Minkov, 2010).

I was not convinced that the research guidelines made an appropriate categorization of value indicators as a certain value dimension. My method for validating the suggested interpretation was to use interviews with students, together with literature studies. I consulted previous research on Swedish mathematics education to better understand the historical, societal and cultural background of the choice of activities in the mathematics classroom, see chapter 2. If activities are indicators of different values due to culture, the conclusion validity of using those mathematical activities as value indicators can be questioned. In the interviews, I looked for items that could be seen as value indicators. Those indicators were then compared to the questions in Section A of the questionnaire. Even if the words students used were not identical, I could analyse the interview answer as the same indicator as in the question in the questionnaire. Several questions were covered.

3.2.3 Ethical Considerations

In conducting interviews and the pilot study, I followed the principles of The Swedish Research Council’s expert group on ethics (2011).

I have informed parent to all participating students under the age of fifteen through personal e-mails about the aim and context of the research, how data collected was to be used, and that students and parents could choose not to participate. Parents of students participating in the interviews in Stage four also gave a written permission for recording the interview.

The first scoping interviews were conducted in home environments with parents present, or in school after having informed parents. In school, two more students came to me because they wanted to participate in my study without parents’ were being informed in advance. Since I recorded only voices and did not use videotape, I decided to include those interviews. Ethical considerations for video-recordings are stricter than voice-recordings (The Swedish Research Council’s expert group on ethics, 2011), but it is still preferable to have parents’ permission before interviewing children under the age of fifteen.

Identities of participants are kept confidential. It is not possible to track schools or individuals that participated. Real names are coded in interview transcripts. In data collected in the pilot study it is not possible to track the individuals’ responses. I have the names of respondents in my source material.
that will be treated confidentially. All participants complied to be part of interviews and/or pilot study. The questions posed and the condition in which the study was conducted gives little concern for negative effects on students. The positive effect may occur that they might reflect more on their valuing of mathematical activities after the study.

3.2.4 Validity and Reliability of the Methods of Translation and Adaptation

Validating a questionnaire can be made either by quantitative methods or by qualitative methods. I will discuss the extent to which my methods of validating the questionnaire can fulfil the objective of keeping the metric equivalence of measured objects.

The English questionnaire has been validated by statistical methods (Seah, 2013). Therefore, most effort was put into the linguistic and cultural adaptation, as well as to the intended group. For this purpose, I decided that qualitative interviews together with a small Pilot Test could fulfil the objectives.

Interviews were conducted either in school, with no parents or teachers present, or in a home environment with parents present. In school, I could see that answers were briefer. This might be an effect of group-attitudes. Interviews conducted at home with parents present allowed more extended answers, and students showed a “good student”-attitude in front of parents. Sapsford (2007) discusses the importance of analysing the accuracy of answers; “To what extent are respondents likely to be lying, or putting the best interpretation on their actions/beliefs?” (Sapsford, 2007, p. 157) There are probably many “truths” about what students’ value, and more important different awareness of what is important when learning mathematics. I cannot be sure if a student really analyses what is most important, or answers what is most fun, or what they usually do in class. Still, these are scoping interviews, not aiming to get the whole picture but an overview of students’ expressions.

The part of the Pilot test that was analysed by quantitative methods was used to discover what questions were difficult for students to understand. A larger sample could improve the validity, especially for questions marked as difficult by one to three students. It is difficult to measure construct and conclusion validity by only quantitative methods. To improve reliability after this small pilot test, we conducted interviews, followed by an analysis of patterns by the translation team. This analysis made us reconsider how to pose questions, see the previous description of stage five above.

4 Results and Analysis

I will in this chapter present the results from the different stages previously described in the methodology chapter. The research questions guided the path of analysis.

4.1 Stage zero: Construct and Conclusion Validity of Section A

In the previous chapter, I discussed the methodology of translating the questionnaire, with most focus on section A. I also discussed that Value Indicators cannot be a measure of values, regardless of
culture and context. In this section, I will show how the construct and conclusion validity are interdepending.

The interviews in Stage zero were used to understand more about the conclusion and construct validity of section A. Four questions from the questionnaire came up in several interviews. 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). I found similarities between the questions, and I will analyse the interpretation of them two by two.

I use a triangulation of methods to arrive at an interpretation what values those two questions can indicate: I use the interpretation in the WiFi Research guidelines (not published), I compare with students answers in interviews, and to literature about cultural and mathematical values.

4.1.1 Questions A) and D): “Problem solving” and “Connecting maths to real life”

Problem solving and connecting mathematics was mentioned by several students in scoping interviews in stage zero. Five of the fifteen-year old 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 WiFi Research Guidelines (not published), problem solving is categorized 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 for them to express “doing something else besides working in the textbook”, as they do not have the vocabulary to express any alternatives other than problem solving. They gave a variety of explanations for why they prefer problem solving, like working together, using more variation, watching the teacher solves problems, having more fun, learning differently, working in pairs and sharing 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 categorize it as one of Bishop’s (1988) Mathematical values. From our interviews it is hard to determine whether students view problem solving as a mathematical content or a tool for learning mathematics.

Concerning cultural value dimensions, Hofstede, Hofstede, & Minkov (2010) 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 about knowing how to do than about knowing how to learn. An individualist society rather tries to provide the competencies necessary for lifelong learning (Hofstede, Hofstede, & Minkov, 2010). 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, but also a different in 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 categorized 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 getting a good grade or a 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 WiFi Research Guidelines (not published), this is categorized as an indicator of mathematics educational value of application. However, 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 cannot be regarded as value indicators. For example, problem solving can have different implications in different cultures, and even between individuals in the same culture. It is very hard to know what value is associated to an indicator like problem solving. Students are affected by different value categories, mathematical values, mathematics educational values, cultural values and probably other values, and we cannot measure which value it is that affects the students’ decision whether problem solving is important or not when learning mathematics.

In other words, there are two problems. First, the questions are wide and open for interpretations. They can be differently interpreted depending on the age and experience of the respondent. Second, these questions do not work well as value indicators, since it is very hard to tell from the valuing of the activity, what value affect students.

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

Both knowing the times tables and practicing with lots of questions relates to different calculation abilities. “Knowing the times tables” was the most common answer from students in scoping interviews. Other abilities, for example addition (“tiokamrater”*, “additionstabellen”) were also mentioned. I associated all those answers to the question “Knowing the times-tables” since they can be considered as equal indicators.

Another common answer, given by five students, ten to thirteen years old, was “working in the textbook”. I associated those answers to the question “practicing with lots of questions”, since textbooks usually are used as a collection of lots of questions. The Swedish School Inspectorate (School Inspectorate, 2009, p. 5) found that working in the textbook is practicing procedural calculations. Students in interviews expressed their view on those activities. Four students, thirteen to fifteen 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.

What underlying value or values can this indicator be indicating? In the WiFi Research Guidelines (not published), the question “Knowing the times tables” is categorized as an indicator of the mathematics educational value of recalling. The question “Practicing with lots of questions” is instead categorized as an indicator of the valuing of effort. Is this interpretation valid out of the explanations expressed by students in interviews? What the Swedish students actually said was “working in the textbook”.

---

* Numbers that add up to ten
* Addition-tables
textbook”, not “practicing with a lot of questions”. We argue, from the Swedish learning context, that “Practicing with lot of questions” is also an indicator of the mathematical value of control, concerned with the mastery of rules and procedures. Both “knowing the times tables” and “Practicing with a lot of questions” as can be regarded as similar indicators in relation to the value of control. The same argument as above allows us to conclude 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, & Minkov, 2010). This means that there is a weak uncertainty avoidance in Sweden. In school, uncertainty avoidance implies students wanting structure and right-answer-questions rather than open-ended questions. Students do not question teachers or textbooks. They expect them to be correct, and their own results are being attributed to circumstances or luck. The opposite position, a characteristic for Sweden, is that students expect to be rewarded for originality; results are attributed to a person’s own ability. The younger students’ answer, which is that procedural activities are important, contradicts the common Swedish value. However, 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. Perhaps there is a development and a socialisation of cultural values between the ages of eleven and fifteen years.

To be able to analyse the relation between value indicators and values, I used interviews from stage zero, as well as a few earlier Swedish studies were consulted, see chapter 2. My results from the scoping interview were once again found in the Pilot Test, see next section. The most common answer from scoping interviews with students was that it is important to work in the textbook (räkna i matteboken). This particular issue has been discussed in the reports (School Inspectorate, 2009; Lundin, 2008). From knowing more about specific conditions in Swedish mathematics education, we can discuss the Conclusion Validity, if we can conclude which value is indicated from the value indicator in the questionnaire.

Choosing proper indicators is crucial to get a good measure of students’ values. When translating and adopting the questionnaire we must consider not only language, but also choosing indicators from a Swedish context that also indicate the intended value. Some issues, like working in the textbook, can be discussed out of extensive research. For other issues, we (the translation team) had to rely on previous studies in the Third Wave Project, as well as Swedish Curriculum (The Swedish National Agency for Education, 2011) and our own experience as mathematics teachers.

Concluding, I find the suggested interpretation to be too narrow. My method of triangulating students interview answers to the questions in the questionnaire, comparing to nature of values and research about Swedish mathematics educational contexts lead me to the conclusion that several values, mathematical as well as cultural, affect students valuing of the two questions. Hence, the construct validity of section A is fair as long as conclusions are drawn on what students value as important when learning mathematics. However, we cannot conclude anything about students’ values. To arrive at concluding anything about students’ values, further analyses are required. I we consider construct validity as fair, conclusion validity is poor, and vice versa.

4.2 Stage four: Pilot Test and Interviews

The aim of the Pilot Test was to check on unclear items, but also to investigate content validity with regard to the intended group. Our Pilot Test was conducted in a class of 27 students of eleven-year
To check for unclear items, we asked them to complete the questionnaire, and while doing so, writing a question mark by every question they found hard to understand.

Totally, in section A, 43 out of 65 questions were marked. Thirteen questions were marked by five students or more, and another five questions were marked by three or four students. In section B, several questions were marked as difficult to understand. However, since the whole class did not have the time to finish reading, I cannot use the numbers for conducting an analysis. Sections C and D were easily understood by students who got the time to read them.

Interviews were conducted with two students from the pilot-sample. They were two eleven-year old girls, we call them Sara and Eva. We conducted semi-structured interviews from the themes described earlier in chapter 3. The questions related to each team is analysed and compared to interview answers.

### 4.2.1 Practising a lot

This theme was important to many students according to the pilot test. A lot of students valued “Practicing with lots of questions” (Öva genom att göra många uppgifter) as Important or Absolutely Important. Another related question is “Doing a lot of mathematics work” (Arbeta mycket med matematik). The responses were quite similar.

![Figure 5: y-axes show the number of students of a total of 28, and x-axes the different alternatives, where 1 is Absolutely Unimportant and 5 is Absolutely Important.](image)

In interviews, we wanted to find out what students valued when they said that practising a lot is important.

Sara expresses that if someone already know mathematics, they do not need to practise.

**Interviewer:** - Do you think you need to practise a lot to learn mathematics?

**Sara:** - Well, if you are already good at it... no!

Her rating of “Practicing with lots of questions” is Neither important nor unimportant”. Later in the interview, she gives us examples of mathematics one need to practise, which is times-tables. She recognises that there is a difference between learning times-tables and problem solving, but cannot express what she find important for learning problem solving.
Eva also says “times-tables” when we ask her for something one need to practise. She mentions the importance of knowing “how to do when you calculate something” (hur man ska göra för att räkna ut något). The interviewer asks if this is about algorithms, but Eva explains that it is rather calculating things like area, solving mathematics exercises. Her answer to both Q36 as well as Q37 is Important.

Sara’s answer forces us to consider what students that do not value practising will answer, Absolutely Unimportant is a strong sentence, and even though Sara explains that she does not need to practise, she chooses the middle alternative. Q28, “Knowing the times-tables”, was the overall most common question students in the pilot test valued as Absolutely Important, 19 students out of 28 respondents. Both respondents mentioned the textbook as important, and we might need to add a question about the textbook.

### 4.2.2 Looking for Mathematics in Real Life

This theme was chosen because answers to this question were spread all over the scale. Related questions, “Relating mathematics to other subjects in school” and “Connecting maths to real life” had a similar distribution.

In the interviews, both girls first couldn’t come up with any example, but then both girls think about the same examples: when shopping, or baking. Eva is asked to elaborate on what professions need mathematics, and she can think about professions she comes up with are cashier, math teacher and professor. She marked that Q10 was unimportant, Q12 was Important and Q39 neither important nor unimportant.

**Interviewer:** - Do you usually think about what use you will have for mathematics in the future, when learning mathematics?

/**/*
Eva: - Yeah, and well like so that you won’t have to work as a garbage lady (laughter)

Interviewer: - I see, so it is important for being able to choose a profession later in life?

Eva: - Yes.

Eva has understood that mathematics is highly valued in different areas in society. There is not any specific mathematical content or a specific situation she values, but rather that mathematics is considered to be a high-stake subject. Respondents have very vague conceptions about the relevance of mathematics in real life, maybe due to their age. Older students, as we saw in the interviews in Stage zero, expressed the need for mathematics in real life. Relating questions within this theme to a specific value is hazardous, since students are not aware of the use and implication of mathematics in real life. My conclusion is that they are not familiar with the importance of mathematics in real life. That could explain the variety of answers.

4.2.3 Feedback or Metacognition

This theme was also formulated since students answers vary a lot. Three questions dealt with how students know what they need to learn, blue is Q44 “Feedback from my teacher”, red is Q45 “Feedback from my friends” and green is Q51 “Learning from mistakes”. Their distribution was quite different. “Learning from mistakes” was valued as Absolutely Important by many respondents in the pilot group. The distribution of answers to “feedback from teacher” and “feedback from friends” has a large variation.

Figure 7: y-axes show the number of students of a total of 28, and x-axes the different alternatives, where 1 is Absolutely Unimportant and 5 is Absolutely Important.

In the interviews, we asked an open question, “How do you know what you need to learn?”. This question was hard for respondents to answer. Instead, we asked what they do when there is something they don’t understand.

Sara explains that she learns from mistakes by looking up the right answer in “facit”, the answer key. Wrong answers are important for learning, however, the answer key does not offer a strategy for
thinking and solving questions. This answer aligns well with the result from the quantitative test, if mistakes are discovered by looking in facit. Sara understands most of the time, and if she doesn’t, she asks the teacher for an individual explanation.

Eva also addresses the teacher with questions. She describes the teachers’ strategy for monitoring students understanding: Teacher explains at the whiteboard, and ask follow-up questions to the class, to check their understanding. Eva also asks friends, and she appreciates explaining to friends: that helps her understand. She says that she needs to solve many exercise, and that those exercises need to be different from each other for learning mathematics.

The respondents seemed not to be used to self-monitoring learning or meta-cognition. It took some reflections and follow up questions before they could express what strategies they had for moving on to learning new content in mathematics. This can explain the large variation of answers.

To sum up, I can conclude that several questions are hard for students to value. If students lack of experience of metacognition and in experience of how mathematics can be used in real life, it is hard to draw conclusions about underlying values. This seems to give a large variation in answers. Perhaps values can be found from questions valued equally by many students.

4.3 Stage one to five: Translations

The meaning of a word or a sentence is never exactly the same when translated from one language to another. I here discuss the results regarding my first research question. I discuss the different options we considered during the translation process, and the decisions we made, and I chose to present some typical and some difficult issues, instead of presenting all questions in the questionnaire. The English Source Questionnaire and the Swedish Target Questionnaire are found in the Appendix 1 and 2. When I write we, it refers to me and Anette De Ron regarding section A. and me and Elisabeth Hector regarding section B, took common decisions in stage two and five.

4.3.1 Linguistic Problems

From the back translation, eight items were analysed as being similar, 47 as keeping their meaning and ten had a slightly change meaning. No item was marked red, a changed meaning. Questions marked as having a slightly changed meaning as well as questions students had difficulties in understanding were chosen for closer analysis.

In this example from the spreadsheet used for the analysis, the first column is the number of the question. The second column is the original question. The third column is the back translation, and the forth column is the suggested Swedish translation. The fifth column is the number of students that found the question difficult to understand.

Color codes in column 2 and 3: green – similar, blue – same meaning, orange – slightly changed meaning
Table 5: Table of back translation and number of students who did not understand the question.

<table>
<thead>
<tr>
<th></th>
<th>Practicing how to use maths formulae</th>
<th>Memorising facts (eg Area of a rectangle = Length x Breadth)</th>
<th>Looking for different ways to find the answer</th>
<th>Looking for different possible answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>to practice using formulas</td>
<td>to find different ways to get the solution</td>
<td>Search for all possible answers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ova på att använda formler</td>
<td>Söka olika sätt att komma fram till lösningen</td>
<td>Söka alla svar som är möjliga</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

The distinction between the colour codes can be discussed. I tried to judge the translation severely and rather use orange than blue, not to miss any problematic questions. Examples of questions that I found problematic from that analysis are presented here.

**Section A: Question 5 - Explaining by the teacher**

This question is an example of grammatical considerations in the translation process. At stage one and two we noticed that we could not use the same grammatical wording, we suggested “Läraren förklarar”, an active form instead of the passive “explaining by”. In stage three, the back translators suggested “When the teacher is explaining”. This is different from the teacher being actively explaining in the Swedish sentence. A closer translation should be “Lärarens förklaringar”, with focus on explanations instead of teacher actions.

In stage four, we asked the pilot-class to mark the questions they did not understand. No one marked this question as being hard to understand. In interviews, both students expressed that listening to teacher explanations was important for learning something difficult. At stage five, we took the general decision to express the questions as activities performed by students, expressed as a full phrase. This lead to the wording; “Lyssna då läraren förklarar”. This is close to the way students expressed themselves, and we judge that students will not answer the question differently from the English question. Hence, the metric equivalence is conserved.

**Section A Question 6: Working step-by-step**

“Step-by-step” and “looking for” are idiomatic expressions in English. At stage one, we could chose a word for word translation. Step-by-step can be translated as “stegvis”, but we judged this as being an expression that eleven-year old students are not always familiar with, at least not in a mathematics learning context. At stage two, we compared with the suggested item distribution list, to see what value this question was supposed to indicate. The question was originally “Working systematically”, and an indicator of valuing a process. The Swedish translation we chose was “Lära en sak i taget”. At stage three, the back translation was “Learn one thing at a time”. There is a difference between working and learning. Working systematically or step-by-step could mean working on a solution, and the learning that takes place then is learning the problem solving process rather than learning mathematical “things”, as suggested in the translation. Nonetheless, when read together with the overall question, “How important is working step-by-step to me when learning mathematics?” it is closer to interpret as students learning one thing at a time. Also, question 56 says “Knowing the steps in a solution”, therefore that question covers the solving process.

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* Teacher explains
* The teacher’s explanations
* Listening to the teacher explaining
In stage four, no respondent indicated that the question was hard to understand. We decided that in mathematics class, working can be considered equal to learning mathematics. The question was therefore not changed in stage five.

Other questions that contain idiomatic expressions are Q15 and Q16: “Looking for…”, and Q55: “Hands-on activities”. In stage one and to, we used “Söka efter vilka svar som är möjliga”. The back translation was “to find…” in Q15 and “search for…” in Q16. Only one student indicated that the question was hard to understand in stage four, but still, in stage five we decided to choose two different translations depending on the context, “pröva” (examine) in Q15 and “undersöka” (investigate) in Q16, since this better describes the activities we want students to value.

Q55 posed greater difficulties. The English expression “hands on” is used in Swedish daily speech, however, in consideration for the age group, we wanted to avoid English expressions. Our suggestion from stage one, “Aktiviteter där jag gör något” was back-translated into “Activities where I’m part”. This was not close enough, and also three students in stage four indicated that they did not understand this question. In stage five, my suggestion is “Göra praktiska övningar (t ex mäta, bygga, klippa papper)“.

Summing up, we had much use of the pilot test together with the back translation when evaluating the linguistic problems.

4.3.2 Cultural Adaptation

Cultural adaptation of the questionnaire consists of both evaluating what mathematical content can be relevant in a Swedish context, but also what activities Swedish students will recognize.

Section A Question 9: Mathematics debates

In stage 1 this was easily translated to “Debatter med matematik”, and the backtranslation in stage three was close enough, “debating maths”. However, when trying out the questionnaire in stage four, eleven students did not understand the question. And when discussing it in stage five, we were not sure how such a debate is enacted in the classroom. It is in the questionnaire item distribution list classified as an indicator of valuing openness as well as valuing exploration. Mathematics debates is not an activity that is common in Swedish classrooms, so out of what it is supposed to indicate, we tried to describe an activity that children could understand. After stage five, the question was “Debattera och ifrågasätta lösningar i matematik”, a cultural adaptation so respondents can visualize a situation. It still relates to valuing openness and exploration.

Other examples where students in our pilot class were not familiar with the suggested activity were:

Q11 “Appreciating the beauty of maths“

Q60 “Mystery of maths (example 111 111 111*111 111 111=12345678987654321)“

The version we tried out in stage four was a close translation, and we changed it in stage five to activities more familiar to students. Our new suggestion is:

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11 Searching for possible answers
12 Activities where I do something
13 Doing practical exercises (e. g. measuring, building, cutting paper
14 Debating and questioning mathematical solutions
To sum up, we found both mathematics content, but also mathematical activities in classrooms that were not familiar to Swedish eleven-year-old students. Therefore, we made some clarifying examples, or changed an activity for a different activity that can indicate the same value.

4.3.3 Adaptation to the Intended Group

There were a few questions in which the activities suggested used mathematical terminology or mathematical content unfamiliar to many students in our pilot group in stage four:

Q8 “Learning the proofs” was changed to “Genomföra bevis, eller visa att något är sant”.

Q31 “Verifying theorems/hypotheses” was changed to “Kontrollera att regler stämmer (t ex visa att en triangle är ett halvt parallelogram genom att dela ett parallelogram på diagonalen och se om trianglarna är lika).

Q38 and Q40, students could not understand the word “formula” (formel). We could not find another word, so we chose to give examples.

Q53 “Teacher use of keywords…” also describes an activity that is not familiar to students. It is categorised as an indicator of valuing facts/truths, and I interpret it as valuing knowing mathematical keywords as well as valuing the right way to do mathematics. I chose to describe a situation that students can recognize. “Inse hur jag ska lösa en uppgift när läraren använder signalord ("dela" signalerar att jag ska använda division)

Q59 “Knowing the theoretical aspects of mathematics (e.g. proof, definitions of triangles)”, Proofs is a very specific mathematical content. It is closely related to valuing rationality. Therefor it is not easy to change for another concept or content. We chose to broaden the question to contain pre-knowledge before proofs, the properties of mathematical objects. Q59: “Lära om teorin bakom matematiken (t ex egenskaper för en kvadrat, att den har fyra lika långa sidor och räta hörn).

Knowledge about what content is well known by students due to the Swedish curriculum helped us adapt the mathematical content to a Swedish cultural context.

4.3.4 Generic Problems from the Source Version

The English source questionnaire is validated statistically (Seah, 2013). We still found from the pilot test some generic problems. The first is that the questionnaire contains too many questions. This was a
common comment from students after having answered section A. After part A and B, the students’ answers to section C were not well elaborated and not very useful. The instruction given was to read and check that they could understand the question, and they did. Therefore I cannot draw any certain conclusions out of students (lack of) answers. Nevertheless, there are general recommendations to avoid too many questions. It will decrease the willingness to participate in the study (Bryman, 2012). We could also see that among the answers we got in section C, there were several nonsense-answers. The questions in section A were divers, sometimes they consists of one word, as Q1 “Investigations”, sometimes it is a student learning activity (Practicing with lots of questions), sometimes a teacher activity (teacher use of keywords), sometimes an abstract learning goal or procedure (learning the proofs). We decided in Stage five to use a more similar way of posing questions: we use entire phrases and suggests activities performed by students. If needed, we provide examples.

A discussion and exchange of experience between research groups in participatingcountries, concerning the problems we have seen, could improve the reliability of the questionnaire.

### 4.4 Construct and Conclusion Validity of Section B

My second research question concerns the Construct and Conclusion Validity of the WiFi-questionnaire. Since the different sections of the WiFi-questionnaire have different question designs, the construct- and conclusion validity will be different in the different sections. Here, I discuss Section A and B.

Section B is intended to measure what component in each value dimension that is more important. The variable measured is again the importance, as in Section A. There is no description in the WiFi Research Guidelines (not published) for how Section B is to be interpreted. The data level of measurement need to be at least an ordinal scale if data should be possible to treat by quantitative methods. There is a choice between letting the middle choice be a zero point, or to use a Likert-scale from one extreme to the other.

I wanted to use the nature of value dimensions when discussing the Conclusion Validity. I therefore analysed each pair by comparing it to the value dimensions described in chapter 2: Mathematical Values, Cultural Values and Mathematics Educational Values. I found no pair that matched a Cultural Value Dimension. Questions 69, 74 and 75 corresponded to mathematics educational values, and the remaining questions to Mathematics Educational Values, as shown in Table 1 (p.47).

The questions in Section B are very similar to descriptions of values. At a first glance, this makes Construct Validity look fair. However, the first problem is: how will students interpret these questions? Will they even understand suggestions like “Using maths for development/progress”? When the English questionnaire is concluded to be statistically validated, has this been considered?

The second problem is the Conclusion Validity. Importance is still the variable we measure, as in Section A. I will discuss this first from the nature of mathematical values, then from the nature of Mathematics Educational Values.

#### 4.4.1 Conclusion Validity of Mathematical Values

In chapter 2, I described how the construction and design of Section B is hard to determine. I will in this section discuss how this affects the possibilities to analyse data from Section B. I will use Q69 as an example for discussing the measuring of importance of mathematical values. First, if we review the
discussion in the Theory Chapter, Mathematical Values like objectism – rationalism are regarded as complementary. That would mean that if a student chooses the middle alternative, neither objectism nor rationalism is important, and we can consider the middle point as our zero point. A scale like this can be used for analysing responses:

Applying maths concepts to solve a problem

Using a rule / formula to find the answer

By introducing the variable of importance, the use of a continuous scale for comparing complementary values is acceptable. Semantic Differences are opposites (hot – cold), and can be distributed along a continuum. But importance can be seen as a continuous variable that varies between objectism as important to rationalism as important.

But if we regard the valuing of the importance of mathematical values, the valuing of objectism and rationalism can overlap. When respondents are offered to mark the middle alternative if both alternatives are equally important, we don’t know anything about the measure of importance.

Applying maths concepts to solve a problem

Using a rule / formula to find the answer

Is objectism and rationalism both important, or both unimportant? I can’t tell by the way the question is posed, due to the fact that the valuing of objectism and rationalism is not complementary. To use importance as a variable for measuring the valuing of objectism and rationalism urges that they are measured one at a time, for example by a Likert Scale as in Section A.

Another option would be to use a nominal scale, respondents’ answers are transferred to a symbol, for example a letter. The distribution of answers can be analysed for each question.

Applying maths concepts to solve a problem

Using a rule / formula to find the answer

What will be lost by this way of analysing responses is the possibility to use numerical methods for comparing different results in different questions.

To sum up, measuring Mathematical Values will need to take into consideration if we intend to measure the importance of a Value or the valuing of the importance of a value. This decision will affect the conclusion validity of Section B.

4.4.2 Conclusion Validity of Mathematics Educational Values

The Conclusion Validity of the questions regarding Mathematics Educational Values in section B will be discussed out of the nature of Mathematics Educational Values.

I use Q67 as an example for discussing the measuring of importance of mathematics educational values. From describing pairs of Mathematics Educational Values as connected by a continuous scale,
data level is at least interval level. If we chose to use one extreme as our zero we arrive at ratio-level. In Q67, one extreme is pleasure and the other is effort. We need to establish the measure of the scale connecting them. If importance is used as the variable, the data level concerns the measure of importance. If a respondent find pleasure important, he or she can check the line close to pleasure, and analogously for effort. A respondent who find pleasure and effort equally important can mark the middle of the line, due to the instruction for answering the question. Therefore, it is not logical to use the middle point as our zero-point. What about a respondent that assign both effort and pleasure as not important? It is likely that that person will mark the middle too, since they are valued to be equally “not important”. Therefore, it is hard to imagine an important-scale with pleasure and effort as extremes, since it is hard to tell what values the measures on this scale should be. The extremes of a scale needs to be opposites and preferably adjectives instead of nouns or verbs. There are a few possible solutions. It is hard to contrast importance of pleasure to importance of effort, since they are not opposites. To compare importance of two activities, the importance needs to be measured for one activity at a time. If we want to keep the pairs, we hence need another measure to connect them. Hofstede et al. (2004) indexed their scales, for example from femininity to masculinity. To do that, they needed several different questions for each dimension.

Another issue is the grammar. Some values are expressed as nouns, for example Pleasure – Effort. But in another pair, values are expressed as verbs, Recalling – Creating. This again highlights the ambiguity about what is measured. Is it the importance of Mathematics Educational Values, or is it the importance of valuing? It is easier for a respondent to answer when questions align grammatically.

Let me discuss some possible interpretations. If importance should be the measure, the importance of Mathematics Educational values can be valued one at a time. For example: How important is Hard Work to you when learning maths?

Important _ _ _ _ _ Not Important

This kind of questioning resembles section A.

Another option is to use semantic differentials connected to the value dimension investigated. Then different aspects, often evaluation, potency and activity, can be measured for a concept.

For example:

Learning Maths by ICT is…

Fun _ _ _ _ _ Boring

Exhausting _ _ _ _ _ Energizing

Important _ _ _ _ _ Not Important

This alternative can be used if we conduct the survey of section B after analysing results from Section A. If we can learn from an analysis of Section A what activities are valued by Swedish students in mathematics learning, we can out of those valued activities create a new section B, consisting of semantic differences for each of those activities.

Mathematics educational values are described in the WiFi Research Guidelines (not published) as dimensional, where each value in a pair of values is an extreme, and should be measured along a continuum. This is similar to the description of cultural values, except that the cultural values are clear opposites. A change of “sign” or a negation will lead to the other extreme, for example “not individualist” is “collectivist”. The pairs that form Mathematics Educational Value-dimensions are not
clearly opposites. For example, consider the pair of Pleasure – Effort, “not pleasure” could be boring, “not effort” could be relaxing. The pairing is not illogical, but it is not transparent either. Instead of the dimension of Recalling – Creating, why can this dimension not be Effort – Creating? To use a scale for measuring concepts, the concepts need to be of the same dimension, like hot – cold, tall – short. I am not convinced that all pairs of Mathematics Educational Values are measurements of the same dimension.

Therefore, a third option is to use radio buttons instead of a scale.

For example:

What is most important when learning mathematics? Choose one in each pair.

- Hard work
- Feeling relaxed
- Challenging exercises
- Exercises on what I already know

A problem with all those alternatives are that one option can be more positive regardless of the importance in mathematics learning. The choice of words becomes important. We are likely to get a different result if we choose different words as value indicators above, for example

To sum up, measuring pairs of Mathematics Educational Values by a scale seems hard to do. It is not transparent or well defined how the pairs are chosen. The valuing of indicators can be measured, but the way the alternatives are presented needs to be reconsidered.

5 Concluding Discussion

I began this thesis by giving an example from France, and the example of Euclidian Geometry: is Euclidian Geometry important for learning mathematics or not? If my first research question is fulfilled, the same result should be obtained if my friend answered the Swedish questionnaire as if he answered the English Source version. The second research question is obtained if we can find differences in our analysis between my friend, valuing Euclidian geometry, and someone who argues that Euclidian geometry is not important for learning mathematics.

In this chapter, I discuss how my results can be used to answer my research questions. That is to conclude what methodology helps us to best fulfil the objectives as stated in the WiFi Research Guidelines (not published). Therefore, I start by discussing the methodological conclusions regarding the translation and adaptation. Thereafter, I discuss how Construct and Conclusion Validity can be improved. I will from both research questions discuss the implications for the WiFi-project.

5.1 Methodological Conclusions

In this thesis I have focused several methodological issues not previously discussed in WiFi Research Guidelines (not published) or earlier reports. To use the WiFi-questionnaire in a Swedish context, not
only a translation is needed, but also a cultural adaptation. I used several methods to obtain metric equivalence while making this cultural adaptation.

5.1.1 Cultural Adaptation and Adaptation to the Intended Group

Translating a questionnaire with questions about mathematical activities does not imply only linguistic aspects, the activities needed to be evaluated out of what mathematical content and what activities Swedish students are familiar with.

The WiFi Research Guidelines (not published) suggested a Back Translation from the Swedish target questionnaire to English. The Back Translated questionnaire was compared to the source questionnaire as a way of validating language validity. However, from our pilot survey, we could conclude that a successful back translation is not enough to ensure that same concepts are being measured. Having our minds set on how to translate questions so that they would suite the back translation resulted in a too close translation. Respondents in the pilot test did not understand all the questions. Therefore, a back translation did not help us neither with the meaningfulness of item content to each culture, or with the metric equivalence. Instead, to deal with issues of cultural contexts and adaptation to the intended group, I could use a methodology developed and described by The International Workshop of Comparative Survey Design and Implementation (Survey Research Center, 2010). This framework helped us investigate linguistic problems, cultural adaptation, adaptation to the intended group and generic problems in the source version (Harkness, Pennell, & Schoua-Glusberg, 2004). I will here describe how this framework helped us improve our translation. The team translation process (Harkness, Villar, & Edwards, 2010) could be adapted to our resources and objectives.

It turned out that students in our pilot group were not familiar with some of the mathematics content that was used in the questionnaire, for example proofs and formulae. We needed to pose questions that students could understand out of a Swedish cultural context. Nevertheless, the cultural adaptation cannot be drawn too far without affecting the instrument validity across languages. Questions in the target questionnaire, VsV, might not measure the same concepts as intended in the source questionnaire, WiFi. The decision we took in the translation team was to keep the questions rather similar to the English source question, and give more examples to improve students’ understanding.

There were also mathematical activities that respondents were not familiar with, for example mathematical debates. By introducing an agent and describing the activity with active verbs, we could improve the understanding of how the activity was enacted. We carefully considered keeping it as an indicator of the same value, to maintain the instrument validity. From our pilot study, we found that respondents were not familiar with proofs, formulae or debates. That can also be a result, but it is not a result of interest when the intention is to measure valuing or values. It is essential that respondents understand the content and the activities they are asked to value.

Doing the interviews and pilot test helped us improve the translation and adaptation of the questionnaire. A second pilot test could be used to confirm this, but it has not yet been conducted. Nevertheless, I found it evident that a back translation was not enough to ensure that Swedish students can understand the questions in the questionnaire. Therefore, I recommend other teams within the WiFi-project, starting up the translation process, to adapt the team translation process and the framework for assessing survey translations as described in this thesis.
5.1.2 Generic Problems

Generic problems from the source version might impact the reliability of data (Harkness, Pennell, & Schoua-Glusberg, 2004). The first generic problem that can affect the reliability is that Section A consists of too many questions. Too many questions will decrease the willingness to participate in a study (Bryman, 2012), and for an eleven-year-old student it is exhausting to answer 65 questions. We could see in our pilot test that in the answers to section C there were a lot of nonsense answers.

Another generic problem we had to deal with is that questions in section A and B were very different amongst each other. After the pilot, we decided to express the questions in a more similar way. In section A, we suggested activities from mathematics classrooms, and those activities contained an active verb and an agent (teacher or student) that conducted the activity. Section B was more difficult. We wanted to keep the metric equivalence, but we wanted each pair to consist of opposites. However, this will make the Swedish section B very different from the English version, which cannot be accepted. Section B needs further evaluations.

In section D, the background questions, there was a question of students’ ethnical background. We considered this question hard to understand for the intended group of respondents, and we were also concerned that ethnicity is a cultural taboo in Swedish context. We excluded that question. Apart from that, sections C and D caused no severe problems in the adaptation process.

Big changes when adapting the target questionnaire will affect the metric equivalence. To facilitate international comparisons it is crucial that respondents to the Swedish questionnaire will respond the same way as they would have responded to the English source questionnaire. That obliges us to keep the target questionnaire similar to the source questionnaire, even with the generic problems we can notice. However, we cannot see what section B can contribute with, and we have considerable difficulties understanding how it can be analysed. Therefore, section B will not be included in the Webb survey. We decided not to use section C in the Webb survey either. Section C will give us texts that call for a partly qualitative analysis. Therefore, we will use a smaller sample of students for section C than for section A. This way, the Webb survey will consist of only section A and D. Hopefully, we will get better quality answers to the Webb survey as well as to section C.

5.2 Validity problems and Implications for analysis

Introducing a discussion of conclusion validity already in the translation stage affects the methodology of translations. We need to know the nature of the variables we want to measure, in order to pose questions that will allow respondents to express an accurate and measurable response. Therefore, the data we wish to gather together with the conclusions we wish to draw affects the construction of the survey. The nature of values has been a question for philosophers from Plato and on. The great divide is if values are shared by a community, or found in an individual. Hannula (2012) problematizes that this question has not been answered within the Third Wave Project. My stance is that on the level of an individual, conclusions on values cannot be drawn from the WiFi or VsV questionnaire. Instead, conclusions can be drawn on what activities students value.

5.2.1 Construct Validity and Conclusion Validity

Considering matters of construct and conclusion validity already in the translating process has helped improve the metric validity of the translated questionnaire.
The WiFi-study uses different theoretical frameworks on values. First, there is the theory of Bishops Mathematical Values (Bishop, 1988). Second, the cultural value dimensions (Hofstede, Hofstede, & Minkov, 2010). There are also an attempt to investigate mathematics educational values, earlier researched within the Third Wave Project (Seah & Wong, 2012; Dede, 2011). The use of both interviews and previous research allowed me and the research team to problematize the suggested interpretation. My results show that the value indicators seem not to be culturally stable. The use of mathematical activities as indicators of different values cannot be used as intended since students values are likely to vary between nations and cultures. The cultural meaning of activities is also likely to be different. Therefore, the activities might indicate different values in different cultures. I can conclude that the construction of the questionnaire is not valid if the intention is to directly measure students’ values. One of the hardest parts to translate was the concept of “values”. In English, values can be both a verb (as in “what students value as important”) and a noun (as in “students’ values”). No real distinction is made in the WiFi Research Guidelines (not published). If students value (verb) problem solving as important, then problem solving is hence a value (noun) (Andersson & Österling, 2013). Therefore, my interpretation is that WiFi measures what students value as important. Out of their valuing, we cannot directly draw any conclusions on their values. To allow value indicators become values is approaching a reification of values rather than measuring something that exists already.

The conclusion that is valid is that the questionnaire can tell us what students value as important in mathematics learning.

### 5.2.2 Implications for the VsV-study

On a cultural or societal level, values might be described. Therefore, gathering quantitative data on what student’s value as important can be used to find cultural patterns. Values might explain those patterns. I take the stance that the valuing by the individual student is influenced by mathematical values, mathematics educational values, culture and probably more at the same time.

A large amount of data will allows us to analyse clusters of what student’s value as important. The international project has evolved, and three countries have finished their analyses: China, Taiwan and Hong Kong (not published). After conducting a principal component analysis, combining their data, they could from the analysis of Section A derive the six most valued things in mathematics learning in those three countries. The next step, to arrive at describing values out of those valued activities or contents, will be interesting to follow. To determine what the values within Swedish Mathematics Educational Contexts are, we have to consider more aspects than what students value as important. In this thesis, I used previous research on historical and societal contexts (Lundin, 2008; School Inspectorate, 2009) in Swedish Mathematics Contexts to better understand what can be concluded on values from the data from the WiFi-survey. For the Swedish part of the WiF-project, I suggest an analysis divided in several steps: First, the data from section A can be used for a factor analysis, or a principal component analysis. Second, an improved version of section B, together with section C, can help us better understand and interpret what students value. The last step is to try to analyse if we can find underlying values affecting students valuing of what they find important in mathematics learning.

The WiFi-project, with a similar questionnaire in fifteen different countries, will allow us to compare what students value as important in different cultures and societies. The questionnaire in this shape might work for research and theory-building on what students value. The study is unique with the perspective on students valuing. From conducting the quantitative survey we will learn more about what activities Swedish students value as important in mathematics learning. In the WiFi-project, the
aim is to learn more about effective teaching due to students’ values. I find it more interesting to research teacher and student alignment of their valuing. Learning more about what students value will allow teachers to align their choices of activities with students’ preferences. The WiFi-study can help to develop a theoretical framework of mathematics educational values, and other values affecting learning in the mathematics classroom.

Finally, I hope my results and findings can bring on a discussion between participating countries. A consensus in matters of construct and conclusion validity is useful for translation teams in the different countries participating. That could help improve metric equivalence between different languages, and thus improve the process of adaptation and translation.

6 References


7 Appendixes and Tables

Table 6: Analysis of values indicated by questions in Section B.

<table>
<thead>
<tr>
<th>Question</th>
<th>Mathematics Educational Value (M E from now on)</th>
<th>Process–Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q66: How the answer to a problem is obtained or What the answer to a problem is</td>
<td>M E</td>
<td>Process–Product</td>
</tr>
<tr>
<td>Q67: Feeling <em>relaxed</em> or having <em>fun</em> when doing maths or <em>Hardwork</em> is needed when doing maths</td>
<td>M E</td>
<td>Pleasure–Effort</td>
</tr>
<tr>
<td>Q 68: Leaving it to <em>ability</em> when doing maths or Putting in <em>effort</em> when doing maths</td>
<td>M E</td>
<td>Ability–Effort</td>
</tr>
<tr>
<td>Q 69: Applying maths <em>concepts</em> to solve a problem or Using a <em>rule</em>/<em>formula</em> to find the answer</td>
<td>Mathematical Value (From here: M V)</td>
<td>Objectism–Rationalism</td>
</tr>
<tr>
<td>Q 70: <em>Truths</em> and <em>facts</em> which were discovered or <em>Mathematical ideas</em> and <em>practices</em> we normally use in life</td>
<td>M E</td>
<td>Facts &amp; Theories – Ideas&amp;Practice</td>
</tr>
<tr>
<td>Q71: Someone <em>teaching</em> and <em>explaining</em> maths to me or <em>Exploring</em> maths myself or with peers / friends / parents</td>
<td>M E</td>
<td>Exposition–Exploration</td>
</tr>
<tr>
<td>Q 72: <em>Remembering</em> maths ideas, concepts, rules or formulae or <em>Creating</em> maths ideas,</td>
<td>M E</td>
<td>Recalling–Creating</td>
</tr>
<tr>
<td>Q73: <strong>Telling</strong> me what a triangle is or Letting me see <strong>concrete examples</strong> of triangles first, so that I understand the properties of triangles</td>
<td>M E</td>
<td>Exposition – Exploration</td>
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<tr>
<td>Q74: <strong>Demonstrating</strong> and <strong>explaining</strong> maths concepts to others (e.g. proofs) or Keeping mathematics <strong>magical / mystical</strong></td>
<td>M V</td>
<td>Openness – Mystery</td>
</tr>
<tr>
<td>Q 75: Using maths to <strong>predict / explain</strong> events, that is, to stay in control or Using maths for <strong>development / progress</strong></td>
<td>M V</td>
<td>Control – Progress</td>
</tr>
</tbody>
</table>