Structure of students' view of mathematics in the Estonian Business School

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Students' mathematics-related beliefs are a decisive parameter for engagement and success in school. In the present research the students' attitudes, beliefs and motivations regarding mathematics at an Estonian university was explored. The paper focuses on describing such a view of mathematics. By means of a confirmatory factor analysis, seven factors were confirmed. The data were collected from 93 first-year mathematics course students in the Estonian Business School through a questionnaire using a Likert-type scale. The study confirmed most of the components identified in earlier studies. It validates the use of the instrument in further studies of beliefs, attitudes and motivation at the university level in Estonia.

Students' beliefs, attitudes and motivation towards the teaching and learning of mathematics play an important role in mathematics education (McLeod, 1992). The study of students' mathematical beliefs has received much attention in recent years. Most of the studies of beliefs have been carried out with a separate focus on cognitive, motivational or affective aspects and only a few contributions have explicitly addressed beliefs as a system (Op 't Eynde & De Corte, 2003). In order to emphasize the present focus on studying the structure of students' mathematical beliefs, we use the term *view of mathematics* in this paper. This term was originally introduced by Schoenfeld (1985) and later adapted by others (Pehkonen, 1996; Pehkonen & Törner, 1996). The students' view of mathematics is a result of their experiences as learners of mathematics and as such, it provides an interesting window through which to study the teaching of mathematics. The *view of mathematics* indicator has been

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developed in 2003 as part of the research project ”Elementary teachers' mathematics” financed by the Academy of Finland. It has been applied to and tested on a sample of student teachers and was modified for the present sample. More information about the development of the instrument can be found e.g. in Hannula, Kaasila, Laine & Pehkonen (2006). The statements in the questionnaire were grouped around the following topics: experiences as mathematics learner, image of oneself as a mathematics learner, and view of mathematics and its teaching and learning. Moreover, mathematical competence is not only about knowledge and skills, but also about the disposition to act in productive ways. The students' view of mathematics is an indication of this disposition. Like Lester, Garofalo and Kroll (1989, p. 75) point out:

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

One of the strategic targets of Estonian higher education for 2006 to 2015 is to use higher education for the benefit of Estonian development and innovation. Scientific work and education is aimed at the needs of our society and economy.

The success of mathematical studies at universities is influenced by emotional as well as social needs (Op 't Eynde & Hannula, 2006). Other important factors that have an impact on the study of mathematics are attitudes, values and understandings (Zan, Brown, Evans & Hannula, 2006; Hannula et al., 2006).

Both of the studies mentioned above (Op 't Eynde & De Corte, 2003; Pehkonen & Törner, 1996) miss one important aspect of the view of mathematics; namely, motivation. There is a general assumption of a relationship between mathematics related motivation and beliefs, yet the theories of their relationships are new (Op 't Eynde, De Corte & Verschaffel 2006; Hannula, 2006). Some items on motivation were included in the Finnish questionnaire, but they failed to form a reliable component (Hannula et al., 2006).

Summarising here, I am interested in students' views of mathematics as a result of their experiences as learners of mathematics in tertiary level. With regard to this focus, I pay attention to the cognitive component described by beliefs as well as to motivational aspects. The choice of concept draws on the following aspects: first, beliefs are often considered to be on a more cognitive side of the affect (e.g. McLeod, 1992). Using ”view” instead of ”beliefs”, I want to emphasize that not all dimensions I address are cognitive ones. Second, I consider the term ”view” more appropriate to capture the structural properties of the affect–cognition interplay in social learning situations. In some sense, the term "beliefs" is separate while "view" is holistic (Roesken, Hannula & Pehkonen, 2011).

Moreover, as soon as mathematics becomes optional in schools, there tends to be overrepresentation of male students over female students and this is also reflected in their respective test performances. This leads to a widening gender gap in performance as students get older. At university level, mathematics programs typically attract mainly male students (Grevholm, 1996; Hag, 1996), although mathematics teacher education programs typically attract more female students (Finne, 1996).). An Op 't Eynde and De Corte's (2003) study showed that girls did not have more positive beliefs than boys in any educational track. In humanities, boys had significantly more positive beliefs about themselves than girls. This indicates that the relationship between beliefs, gender and context is a rather complex one. Andrews, Diego-Mantecón, Op 't Eynde and Sayers (2007) discovered that girls, regardless of age or nationality, were less positive in their beliefs about their own competence than boys. In terms of mathematics being inaccessible and elitist, they found that both males and females shared a negative view; however, females had a significantly more negative viewpoint. Finally, they found that both the boys and girls in their study were equally positive in terms of their teachers as facilitators of their learning and of the relevance of mathematics to their lives. These results in affect provide explanation to why female students choose usually not to study optional mathematics.

Some studies about students' and teachers' attitudes in basic or upper-secondary schools have been carried out in Estonia (Lepmann, 2000; Lepmann & Afanasjev, 2005; Pehkonen & Lepmann, 1994; Kislenko, 2007; Kislenko, 2008). However, research into students' views of mathematics at the university level in Estonia has not been conducted. The purpose of this research is to examine the opinions of students in order to increase the motivation among them to study mathematics.

The aim of this research was to join together the best parts of some of the published instruments on mathematical-related beliefs. This new instrument was then used to a) confirm its applicability in Estonia at the university level, b) compare study language differences in the students' view of mathematics, and c) compare gender differences in the students' view of mathematics.

Methodology of research

This paper focused explicitly on studying the structure of students' mathematical-related beliefs, and to emphasize this, the paper focused on the *view of mathematics*. I am interested in students' view of mathematics as a result of their experiences as learners of mathematics. For the dimensions of students' view of mathematics, Op 't Eynde, De Corte and Verschaffel (2002) identified three main categories of belief-related research which helped them to form the development of their instrument. These were beliefs about mathematics education, beliefs about the social context and beliefs about oneself as a learner of mathematics. Op 't Eynde and De Corte (2003) tried to develop, from a warranted theoretical perspective, a comprehensive instrument for the assessment of students' beliefs about mathematics, and its teaching and learning. The questionnaire (Op 't Eynde & De Corte, 2003) was developed for and evaluated on Flemish students. Their survey was conducted to investigate the nature of students' mathematically related belief systems. A mathematics-related beliefs questionnaire was developed and administrated to 365 Flemish junior high school students to gather data to identify and analyse the different components of students' belief systems. The focus was on the structure of the belief systems, the relevant categories of beliefs and the ways they relate to each other. The analysis dealt with if the nature and structure of beliefs and belief systems pointed to the social context, the self, or the object to which the beliefs related as constitutive of the development and functioning of the systems. The questionnaire developed, the *Mathematically related beliefs questionnaire*, contained 58 items. The four-factor model resulting from a principal component analysis of survey responses showed that there was some empirical ground for the proposed structure of students' mathematically related beliefs. Factor 1 (beliefs about the role and function of their own teacher) referred to the social context, Factor 2 (beliefs about the significance of and competence in mathematics) to certain beliefs about the self. Factors 3 (mathematics as a social activity) and 4 (mathematics as a domain of excellence) were related to beliefs about mathematics. Their study showed clear evidence for the relevance of students' beliefs about the self in relation to mathematics, the conceptions of their competence in mathematics and their views on the personal relevance of mathematics. An adaptation of the mathematics-related beliefs questionnaire (Diego-Mantecon, Andrews & Op 't Eynde, 2007) reported on an attempt to refine the questionnaire in order to determine empirically the structure of Spanish and English students' mathematics-related beliefs; thus, the questionnaires were transferred outside the original Flemish context.

In addition, Rösken et al. (2007) primarily focused on the systematic character of beliefs and they were interested in the dimensions describing such a view of mathematics. In the study (Rösken et al., 2007), they used a modified questionnaire to collect and analyse data from a sample of secondary school students. By means of an exploratory factor analysis, they obtained seven dimensions structuring this construct. Reliable scales described these dimensions and they analysed one of them, competence, in detail by considering the effects of course choice (general or advanced courses). They examined the relations between the dimensions and what structure they generated; thereby, a core of three highly correlating dimensions (competence, difficulty of mathematics, and confidence) was identified. Their study involved 1436 randomized selected students from secondary school, grade 11, from all over Finland. The study of Rösken et al. (2007) supported the model for describing students' view of mathematics found when analysing the data of elementary student teachers (Hannula et al., 2005, 2006).

Sample of research

This study was carried out in Estonia at the university level. The Estonian Business School is a private business school of university standing, offering bachelor's, master's and doctorate level programs in the fields of business administration, public administration and information technology management. It has 1500 students. The questionnaire was administrated during the lectures of three lecturers. The student groups that were administrated the questionnaire were two groups of business students from the full-time study program and one group of business students from the part-time program. One group of business students was from the full-time study program learning in English and the students in this group are basically not Estonian (international group of Russian, Finnish, Italian, French etc. students). These three groups followed different curriculums, but mathematics courses were similar. The participants were 93 volunteer bachelor students taking at least one first-year compulsory math course at the university level. The survey was completed during the mathematics lectures that were compulsory for the students and participation was voluntary. The response rate was 77 %. There were 50 males and 43 females; 48 students studying in Estonian and 45 students studying in English. The average age of responding students was 23.1, minimum 18 and maximum age 43.

Instrument and procedures

The view of mathematics indicator used in this research was developed in 2003 as part of a research project in Finland. The statements in the questionnaire are grouped into seven topics (Rösken et al., 2007), which do not include motivation. I have modified Rösken et al.'s questionnaire to include items on motivation that were adapted from Midgley et al.'s (2000) personal achievement motivation questionnaire in order to collect and analyse data from a sample of university students. The mathematics-related beliefs questionnaire was developed at the University of Leuven, Belgium (Op 't Eynde & De Corte, 2003; Diego-Mantecon, Andrews & Op 't Eynde, 2007). In the study, a quantitative (questionnaire) research strategy was used. The questionnaire was used to investigate students' beliefs and motivation towards mathematics teaching and learning.

The questionnaire used in Estonia was translated before the pilot study into Estonian and back to English. As one of the aims of the pilot study was to make a comparative analysis, then the translation had to have been carried out with a high degree of caution. Gorard's (2001, p. 91) suggestion will be followed during the study where he recommends that:

> [...] if you are working in one language and translating your instrument into another language before completion (a common process for overseas students), then use the techniques of back translation as well. In this, the translated version is translated back into the original language by a third person as a check on the preservation of the original meaning.

Since purpose of the study was to confirm the earlier scales on beliefs (Rösken et al., 2007; Diego-Mantecon, Andrews & Op 't Eynde, 2007), attitudes (Yusof & Tall, 1994) and motivation (Midgley et al., , 2000), the original scales from the earlier research were used (see the appendix) and their reliabilities were computed. Moreover, the structure of the view of mathematics was explored through calculating correlations between the reliable components.

Participants filled in a questionnaire on paper. The students were asked to respond on a Likert scale (4 options: strongly disagree, partly disagree, partly agree, and strongly agree). In this study used 4 points scale because I wanted that students will make decision and they cannot choose neutral position. Also Midgley, Feldlaufer and Eccles (1989) used 4-point Likert scale in their longitudinal study of 1301 students and teachers relations and attitudes toward mathematics.

The students were given 40 minutes to fill in the questionnaire and told the questionnaire was anonymous. I collected 93 questionnaires from 2 study groups: 1) fulltime and part-time students studying in Estonian (63 students) and 2) fulltime students studying in English (30 students).

Since the purpose was to confirm the field of structuring students' view of mathematics, the same component names were used: *Personal achievement goal orientations*, *Mastery goal orientation*, *Attitudes to mathematics*, etc.

Results of research

The summarize results are presented in table 1. The Cronbach's alpha shows reliability. I also calculated the mean scores and variances for the whole sample (n = 93) on each of the components. The original Cronbach's alpha is the alpha which is used in earlier studies of previously published instruments.

Table 1.*The ten factors of the students' view of mathematics*

Factors	Sample item	Original Cronbach's alpha	Cronbach's alpha in pilot study	Mean	Variance
F1 Performance-Approach Goal Orientation	It's important to me that other students in my class think I am good at my class work.	0.89	0.87	2.42	3.43
F2 Mastery Goal Orientation	It's important to me that I improve my skills this year in mathematics.	0.85	0.75	2.84	2.35
F3 Mathematics as a Rote-Learnt Subject	Learning mathematics is mainly about having a good memory.	0.76	0.44	2.92	0.14
F4 Attitudes to Mathematics	Mathematics is about solving problems.	0.82	0.73	2.53	1.19
F5 Relevance	Knowing mathematics will help me earn a living.	0.88	0.80	3.02	0.09
F6 Personal Value of Mathematics	Mathematical developments usually help to improve the economy.	0.74	0.74	3.0	1.59
F7 Student Competence	Mathematics is a challenge for me.	0.92	0.84	2.35	0.91
F8 Teacher Role	My lecturer explains why mathematics is important.	0.92	0.58	2.39	0.38
F9 Cheating Behavior	I sometimes copy answers from other students during tests.	0.87	0.87	1.80	0.98
F10 Effort	I have to work very hard to understand mathematics	0.83	0.64	2.70	0.82

The Cronbach's alpha is a coefficient of reliability. It is commonly used as a measure of the internal consistency or reliability of factors for a sample of examinees. If the Cronbach alpha is 0.7 or higher, then we can say that the factor is confirmed. In this study, the factor analysis confirmed 7 factors: F1 *Performance-approach goal orientation*, F2 *Mastery goal* *orientation*, F4 *Attitudes to mathematics*, F5 *Relevance*, F6 *Personal value of mathematics*, F7 *Student competence* and F9 *Cheating behaviour*. Three factors did not confirm for low reliability.

Initially structure of the students' views of mathematics was obtained. Relations between the dimensions were calculated for the confirmed 7 factors.

Table 2. *Correlations between the factors*

	F1	F2	F4	F5	F6	F7	F9
F1 Performance-Approach Goal Orientation	1						
F2 Mastery Goal Orientation	0.348**	1					
F4 Attitudes to Mathematics	0.229*	0.534**	1				
F5 Relevance	0.014	0.572**	0.424**	1			
F6 Personal Value of Mathematics	0.053	0.585*	0.488**	0.825**	1		
F7 Student Competence	0.278**	0.542**	0.411**	0.541**	0.480**	1	
F9 Cheating Behaviour	0.160	-0.344**	-0.106	-0.226*	-0.111	0.284*	1

Table 2 shows that nearly all dimensions correlate statistically significantly with each other. All correlations with the sign ** are significant at the level 0.01 (2-tailed). Correlations with the sign * are significant at the 0.05 level (2-tailed). However, the strength of the correlation varies from little if any (0.00 to 0.29) to high (0.70 to 0.90) in the pilot survey. Moderate correlations are the following factors: *Mastery goal orientation* (F2) and *Attitudes to mathematics* (F4) were found to correlate with a coefficient of 0.534; *Mastery goal orientation* (F2) and *Relevance* (F5) were found to correlate with a coefficient of 0.572; *Mastery goal orientation* (F2) and *Personal value of mathematics* (F6) correlate with a coefficient of 0.585. *Mastery goal orientation* (F2) and *Student competence* (F7) correlate with a coefficient of 0.542. That is, students' learning is perceived as inherently interesting, they feel competent to do mathematics and have a positive attitude to mathematics. *Relevance* (F5) and *Student competence* (F7) correlate with a coefficient 0.541. The high correlation of 0,825 between *Relevance* (F5) and *Personal value of mathematics* (F6) indicates that these components are measuring essentially the same thing. The correlations of the rest of the factors are weak.

I analysed both study groups' mean scores separately. Comparing the distributions in table 3 for factors as well as arithmetic means leads to an average students' view of mathematics in the individual study groups.

Table 3. *Group statistics, means and standard deviations for the factors regarding course languages*

Dimension	Language	Mean	Standard deviation
F1 Performance-Approach Goal Orientation	Estonian	1.76	1.55
	English	2.12	0.68
F2 Mastery Goal Orientation	Estonian	2.84	0.62
	English	2.85	0.60
F4 Attitudes to Mathematics	Estonian	2.58	0.42
	English	2.50	0.50
F5 Relevance of Mathematics	Estonian	3.08	0.52
	English	3.01	0.68
F6 Personal Value of Mathematics	Estonian	2.70	0.33
	English	2.68	0.43
F7 Student Competence	Estonian	2.30	0.33
	English	2.43	0.43
F9 Cheating Behaviour	Estonian	1.72	0.88
	English	1.88	0.90

T-tests for the equality of means (independent samples) for dimensions show that F1 *Performance-approach goal orientation* has a significant difference (t = -2.410, df = 92, p = 0,018) and F7 *Student Competence* also has a significant difference (t = -2.031, df = 92, p = 0,045). We can see that students in the English group are more motivated and demonstrate more competence than students in the Estonian group. No statistical differences are seen in F1 *Mastery goal orientation*, F4 *Attitudes to mathematics*, F5 *Relevance of mathematics*, and F9 *Cheating behaviour*. These dimensions are relevant to student learning both in Estonian and in English.

Table 4. *Group statistics, means and standard deviations for the factors regarding gender*

Dimension	Gender	Mean	Standard deviation
F1 Performance-Approach Goal Orientation	Male	2.34	0.89
	Female	2.45	0.97
F2 Mastery Goal Orientation	Male	2.81	0.62
	Female	2.86	0.64
F4 Attitudes to Mathematics	Male	2.51	0.43
	Female	2.55	0.47
F5 Relevance of Mathematics	Male	3.13	0.59
	Female	2.96	0.61
F6 Personal Value of Mathematics	Male	3.08	0.61
	Female	2.90	0.66
F7 Student Competence	Male	2.35	0.37
	Female	2.35	0.42
F9 Cheating Behaviour	Male	1.99	0.91
	Female	1.56	0.82

Only for F9 does the *t*-test for equality of means (independent samples) show a statistically significant difference ($t = 2.404$, $df = 91$, $p = 0{,}018$) and we can say that female cheating is less than male.

Discussion and conclusions

The Cronbach's alpha is commonly used as a measure of the internal consistency reliability of a questionnaire. If the reliability coefficient is 0.70 or higher, it is considered to be ”acceptable” in most social science research situations. In table 1 seven factors had a high Cronbach's alpha and their reliability for Estonian university students was confirmed. The reliability of three scales used in the study was not confirmed. However, those that were not found to be reliable were not far from the threshold level. One task of the survey was to check the reliability of the questionnaire. That means that we can use the questionnaire later for the survey. Seven reliable factors for students' views of themselves as learners of mathematics were obtained. Based on the study analysis, the structure of the first-year baccalaureate students' views of mathematics is coherent with the structure from other researches' structures (Op 't Eynde and De Corte, 2003; Rösken et al., 2007; Midgley et al., 2000). This gives a positive signal about the usefulness of the instrument, as the component structure remains stable in different populations. The factors F1 and F2 are personal achievement goal orientations. This refers to students' reasons or purposes for engaging in academic behaviour. Different goals foster different response patterns. These patterns include cognitive, affective, and behavioural components, which have been characterized as more or less adaptive. A performance-approach orientation has been associated with both adaptive and maladaptive patterns of learning. *Mastery goal orientation* has been associated with adaptive patterns of learning. The factors F4, F7 and F10 relate to personal beliefs. The factors F5 and F6 relate to emotional expressions. Thereby, factor F7 *Student competence* describes a more static view on abilities and competencies concerning doing mathematics. Two factors relate primarily to social context variables; namely, *Teacher role* (F8) and *Cheating behaviour* (F9), and one to mathematics as a subject; that is, *Mathematics as a rote-learnt subject* (F3).

The correlation matrix indicates these four factors are more closely related because of a high correlation: *Mastery goal orientation* with *Attitudes to mathematics*, *Relevance*, *Personal value of mathematics* and *Student competence*. If the students have a positive attitude, their motivation is higher. If the students see real-life applications in mathematics, then they are more motivated. That is, for students learning is perceived as inherently interesting and they feel competent to do mathematics and have a positive attitude towards mathematics. The factor *Mastery goal orientation* is the core of the students' view of mathematically related beliefs. The factor F5 *Relevance* and F7 *Student competence* are related moderately. The correlation shows a positive relationship between the understanding that students know how useful the study of mathematics is and they are good at it. The high correlation of 0,825 between F5 *Relevance* and F6 *Personal value of mathematics* indicates that these components are measuring essentially the same thing.

A positive relationship between *Mastery goal orientation* and achievement is fairly well confirmed (Friedel, Cortina, Turner & Midgley, 2007; Midgley et al., 1998). The relationship between *Performance goal orientation* and achievement is less clear (Midgley et al., 2000). Some studies have identified *Performance goal orientation* to be related to a negative learning behaviour, while other results indicated performance orientation to lead to positive learning behaviour and achievement (Freeman, 2004; Midgley et al., 1998.) This confusion has led to a differentiation between performance-approach and performance-avoidance goal orientations (Elliot & Harackiewicz, 1996; Lehtinen, Kuusinen & Vauras, 2007).

In table 3 the dimensions are mostly relevant for students learning in Estonian or in English in the survey. Both groups perceive the subjects equally. The lowest agreement is in *Performance-approach goal orientation* (F1). The neutral position close to agreement is in Students' Competence (F7). The highest agreements are in the *Relevance of mathematics* (F5), *Mastery goal orientation* (F2) and *Personal value of mathematics* (F6). However, there are language differences. The English group is more motivated and they feel more competent than the students in the Estonian group.

In table 4 the dimensions are mostly relevant for male (50) and female (43) students. Both groups perceive the subjects equally. The lowest agreement is in *Cheating behaviour* (F9). Only for F9 does the *t*-test for equality of means (independent samples) show significant difference (Sig. 2-tailed is 0,018) and we can see that females cheat less than males. The neutral positions close to agreement are *Performance-approach goal orientation* (F1) and *Students' competence* (F7). The highest agreements are in the *Relevance of mathematics* (F5), *Personal value of mathematics* (F6) and *Mastery goal orientation* (F2). In our study, mathematics is not clearly gender marked as male, especially concerning the joyfulness of the subject, such as success, interest and importance in the future. There was also no significant difference in hard work. We cannot say that hard work is perceived as more female.

While there is a substantial amount of research in mathematics education at the school level, the amount at the tertiary level is still modest. Some tertiary studies, e.g., those investigating the effects of gender or the kinds of students succeed in mathematics; have been conducted by mathematics education researchers without a particularly strong background in tertiary mathematics (Selden & Selden, 2001). However, there has not been an investigation of students' views of mathematics in Estonia at the university level and thus in the present day it is an unexplored area in Estonia. In Nordic countries and in Baltic States the field of affect in mathematics at university level is almost uncovered theme. In these countries are only few studies at university level (Juter, 2005). Also in the special issue of ICMI Study *The teaching and learning of mathematics at university level* does not cover the field of affect. Now, this study confirmed the structure of students' view toward mathematics in Estonia at the university level and reported the first results of this view. The topic is important, as is the idea of improving the quality of instruments used to confirm students' affective responses to mathematics. There is great value in attempting to build on previous work in this area by synthesising conceptual frameworks and validating new instruments that combine scales and items from previous studies. Especially important is the reliability of instrument for different populations, whether this involves students at different educational levels or respondents in different countries where one might expect to find different educational cultures.

For identical items in both populations I found the same factor structure and reliability analysis confirmed internal consistency of seven factors. The structure of the Estonian first year baccalaureate students' views of mathematics is coherent with the structure from earlier research (Rösken, et al., 2007, Diego-Mantecon, Andrews & Op 't Eynde 2007, Yusof & Tall, 1994; Midgley et al., 2000; OECD, 2009; Kislenko, 2007). This gives a positive signal about the usefulness of the instrument, as the component structure remains stable in different populations.

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Appendix

Reliable scale's questions.	Loadings
F1 Personal achievement goal orientations (*Performance-approach goal orientation*) (Cronbach's alpha =0,87)	
1. It's important to me that other students in my class think I am good at my class work.	0,900
2. One of my goals is to show others that I'm good at my class work.	0,927
3. One of my goals is to show others that class work is easy for me.	0,880
4. It's important to me that I look intelligent compared to others in my class.	0,866
F2 Personal achievement goal orientations (*Mastery goal orientation*) (Cronbach's alpha =0,75)	
5. It's important to me that I improve my skills this year in mathematics.	0,811
6. I am very motivated to study mathematics.	0,928
7. It's important to me that I thoroughly understand my class work.	0,781
8. It's important to me that I learn a lot of new mathematical concepts this year.	0,815
9. One of my goals is to master a lot of new skills this year.	0,679
10. One of my goals in class is to learn as much as I can.	0,886
F4 Attitudes to mathematics (Cronbach's alpha =0,73)	
11. Mathematics is a collection of facts and processes to be remembered.	-0,754
12. Mathematics is about coming up with new ideas.	0,876
13. I learn mathematics through memorization and repetition.	-0,771
14. I usually understand a mathematical idea quickly.	0,868
15. Mathematics is about solving problems.	0,732
16. I cannot connect mathematical ideas that I have learned.	-0,750
F5 Relevance of mathematics (Cronbach's alpha =0,80)	
17. Some knowledge of mathematics helps me to understand other subjects.	0,849
18. Knowing mathematics will help me earn a living.	0,782
19. I think mathematics is an important subject.	0,817
20. Studying mathematics is a waste of time.	-0,859
21. I can use what I learn in mathematics in other subjects.	0,798
22. I study mathematics because I know how useful it is.	0,836
23. Mathematics enables us to better understand the world we live in.	0,912
24. I can apply my knowledge of mathematics in everyday life.	0,827
F6 Personal value of mathematics (Cronbach's alpha =0,74)	
25. Mathematical developments usually help to improve the economy.	0,806
26. A knowledge of mathematics is important; it helps us to understand the world.	0,887
27. Mathematics is useful for our society.	0,885
28. After graduating university, I will have many opportunities to apply my mathematical knowledge.	0,872
F7 Student competence (Cronbach's alpha =0,84)	
29. Mathematics was my worst subject in high school.	-0,806
30. Mathematics is hard for me.	-0,910
31. I am good at mathematics.	0,912
32. I think that what I am learning in mathematics is interesting.	0,838
33. Compared with others in the class, I think I am good at mathematics.	0,857
34. I understand everything we have done in mathematics this year.	0,874
F9 Cheating behaviour (Cronbach's alpha =0,87)	
35. I sometimes copy answers from other students during tests.	0,927
36. I sometimes cheat whilst doing my class work.	0,914
37. I sometimes copy answers from other students when I do my homework.	0,862

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