Where are the best mathematics students hiding in Slovenia?

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Abstract

In Timss Advanced study mathematical knowledge of students was compared among countries with large differences in the proportion of students learning advanced mathematics to the whole age cohort in the country, called coverage index. In Slovenia, all future university students were defined as advanced mathematics students, and therefore coverage index is very high, 40 %, which is from 2 to 20 times larger than in other countries. Slovene TIMSS Advanced achievement was slightly lower than international average. We present results of comparisons of TIMSS achievement of smaller groups of students in Slovenia which are comparable to populations of advanced mathematics students in other participating countries regarding their coverage indices. The clustering analyses was used to find such groups and define their characteristics based on student background and learning environment. TIMSS achievement of specific group is very high so these students could be candidates for more advanced mathematics program in gymnasia. Characteristics of successful students grouped by similarities in learning environment provide ideas for teaching strategies linked to the highest achievement of students.

Key words: advanced mathematics, coverage index, clustering, student background, learning environment

Introduction

In the TIMSS Advanced study, Slovene students achieved the average of 457 points on the scale with international average of 500. Three countries, Russian Federation, Netherlands and Lebanon scored above the international average and Iran scored similar to the international average. Five countries beside Slovenia had achievement lower than international average. As the TIMSS Advanced study compares differently organized educational systems during the last year of secondary schools, achievement should be observed together with the TIMSS coverage index, the percentages of students learning advanced mathematics as part of the whole population of young people in appropriate age in the country. The coverage indices range from 0.7 % in Philippines to over 1.5 % in Russian Federation, four countries having up to 10 % and Italy 19.7 % as compared to Slovenia with very large coverage index of 40.5 %. In general, more specialized populations or

lower coverage indices had higher mathematics achievement (Mullis, Martin, Robitaille, Foy, 2009) Slovenia has the large coverage index because the entire population of future university students follow the same, most advanced mathematics program in secondary school. In other countries, TIMSS Advanced populations are students who are enrolled in more advanced or additional mathematics programs leading to mathematically oriented university studies (Mullis, Martin, Robitaille, Foy, 2009). TIMSS Advanced findings and trends from 1995 in Slovenia started the discussions between policy makers whether keeping all population in the same demanding mathematics program or provide more mathematics programs with different level of difficulties. This study intended to find whether in Slovenia exist groups of students who could be candidates for such programs and present comparisons of their mathematics achievement.

Problem

The large TIMSS Advanced mathematics coverage index in Slovenia comes from the tradition of the school system which requires from applicants for any university study to finish the general secondary school, called gymnasium and pass the final examination, matura, at the end of it. The national gymnasia program is the most advanced program in the country for all subjects, also for mathematics. Over recent years, almost 40 % of all elementary school students decide to study at universities leading them to choose gymnasia as their secondary school. As a consequence, almost 40 % of all secondary school students in age cohort are enrolled in the most advanced mathematics course in the country.

The final examination in grade 12, called matura, consists from three compulsory (mathematics, mother language and first foreign language) and two optional subjects by student choice (i.e. any school subject such as physics, history, second foreign language). Final matura grade, used as criterion to accept students into university studies with a limitation on the number of future students, is the sum of grades from all five matura subject exams. In case of mathematics matura exam, students may choose between basic or advanced level of difficulty, expressed by the standards of knowledge required to be demonstrated at each level, 9 months before the exam. Their preparation lessons for matura exam are mathematically more demanding than preparation for student choosing basic level, but both cover the same curriculum content. At the advanced level of math matura exam, students can get maximum grade 8 while the maximum grade at basic level is 5. Choosing the advanced level of final mathematics exam therefore increase students' chances to be accepted into university studies with limitations on the number of students independently of the area of study. However, student's decision for the advanced level is also connected to motivation

and self-confidence in mathematics. In the national study of comparisons between TIMSS Advanced results and grades given at mathematics matura exam in 2008 it was found that there are relatively many girls choosing basic level of mathematics matura exam but reaching the highest international benchmark level by their achievement in TIMSS Advanced (Cankar, Japelj Pavešič, 2010). In other research, girls are also found to have lower self-confidence in mathematics and low motivations for learning advanced mathematics than boys but also paradoxical higher grades from mathematics than boys (Preckl, Goetz, Pekrun, Kleine, 2008). In Slovenia, in TIMSS Advanced study, girls were found to get higher grades in school than boys for similar demonstrated knowledge of mathematics in TIMSS tests. Girls in grade 12 with the highest grade 5 from mathematics in school had TIMSS Advanced mathematics achievement 529 (s.e. 8.9), not different from achievement of boys with grade 4, 520 (s.e. 7,5) while boys with grade 5 achieved 560 (s.e. 8.5) points (Japelj Pavešič, Svetlik, Kozina, Rožman, 2009).

The problems of advanced mathematics Slovene general schools are low motivation for learning most advanced mathematics amongst students who are able but do not need high grades to enter university because of no limitations for studies in the areas of science, mathematics and engineering, and low motivation for general mathematics in school amongst students who do not intend to choose studies connected with or requiring mathematical knowledge, such as social science or philosophy. Mathematics teachers express complaints that with higher percentages of gymnasia students in age cohort every year, the mathematical knowledge decreases. Teachers have to adapt teaching mathematics more and more to less able and less motivated students because they need to help them pass the final mathematics exam. More able students feel, in such a system, less attention from teachers and have less opportunity to achieve a higher level of knowledge. Most likely they also lose motivation for higher mathematics. By the other side, girls have higher grades already in elementary school therefore can easily get to gymnasia with limitations on entrance and present two thirds of gymnasia student population. They receive higher grades than boys in gymnasia again and are in better positions to enter most wanted university studies. The mathematics program in school should therefore help most able girls to become self-confident and recognized as equally successful in mathematics as boys as well as help most able boys to be graded in accordance to their high level of mathematical knowledge and support both to achieve most in the area of mathematics.

Discussions about introducing more advanced mathematics course are taking place amongst policy makers and teachers during recent reform of secondary school curricula and organization. Support for the new most advanced mathematics program is coming also from research showing that

programs for mathematically oriented students should have specially defined curriculum with a focus on important math concepts for future development of mathematics knowledge rather than just math puzzles and challenging problems added to curriculum for regular mathematics program (Gavin, Casa, Adelson, Carrol, Sheffield, 2009). To develop new advanced mathematics courses a subpopulation of students who could be the applicants for them should be recognizable in the school system in advance. Research questions asked in the presented study were whether groups of successful mathematics students have common recognizable characteristics and which characteristics of teaching process lead to the highest mathematical knowledge of students as well as how high is mathematical achievement of comparable groups in Slovenia with more specialized advanced mathematics populations in other countries.

Methodology

The research was done in two parts. In the first part, basic statistical analysis of the Slovene student achievement data and students, teacher and school background data collected in TIMSS Advanced 2008 was used to find the achievement of the more specialized sub-population inside the population of Slovene TIMSS Advanced students, defined by students's chosen level of mathematics final exam, school grades from mathematics, planned area of study and higher motivation for learning mathematics.

The aim of the analysis in the second part was to define groups of students with similar characteristics and test whether these groups show differences in their TIMSS achievement. The method of hierarchical clustering for units described by symbolic data was found to be the most appropriate. In comparison to usual clustering, the method for clustering symbolic data assigned students to groups regarding real values of variables without calculating the "average" value of variables with nominal scales. The method of clustering takes into account all variables at the same time and assigns students who has similar answers or variable values to given number of clusters or groups. For grouping students, chosen optional answers to background questions for students and teachers about their attitudes toward mathematics and learning or teaching mathematics were used. Answers chosen by high percentages of students in each group were considered as characteristics of that group.

From all background variables available in TIMSS database we selected those variables which show statistically significant differences in achievement between more (achievement 500 or more) or less successful (achievement less than 500) Slovene students in TIMSS advanced. As shown in

table 1, in Slovenia, 28.5% of TIMSS Advanced students achieved 500 points or more. This is 10.9 % of students from the whole age cohort and is closer to the coverage indices of other countries in TIMSS Advanced study. The mean achievement of students over 500 points was 553 points, similar to the mean achievement in The Netherlands.

Table 1: Achievement of Slovene students over and under the international average

national benchmark	Percent	Percent (s.e.)	Mathematics Achievement	Math. Ach. (s.e.)
under 500 points	71.47	1.90	418.87	3.66
over 500 points	28.53	1.90	553.83	2.14

Then we divided selected variables into two categories, the background of the students (such as attitudes of students toward mathematics and students' background, home environment, education of parents, socio-economic status and perception of future education) and the background of learning mathematics (such as descriptions of real learning in school, lessons, teacher's report about realization of teaching in class, the student's view of the teacher characteristics and the school climate).

Two databases were formed with variables from each list together with student's identification. Both data files contained no variables describing student achievement. With the heuristic clustering algorithm implemented into the computer software Clamix (Korenjak-Černe, Batagelj, 2002), many solutions of clustering of students were obtained. The solutions in which students were most similar inside all groups, for the clustering of student by background characteristics and for clustering of students by characteristics of learning mathematics were chosen as final results. The values of variables which were reached by a high percentage of students in each cluster helped us to describe the nature of the two sets of clusters.

In the last step, the assignments to clusters were added as a variable to the initial data base of students with all variables, including achievement. The usual statistic analyses to compare achievement over groups were performed with the program IDB Analyzer to take care of sampling and weight issues of TIMSS database. Comparisons of achievement between clusters were discussed together with characteristics of each cluster.

Results

The initial analysis showed large differences in achievement of students regarding their motivation for mathematics, observed by taking advanced or basic level of mathematics final exam and liking mathematics, as shown in Table 2.

Table 2: TIMSS Mathematics achievement of students according to their liking of mathematics

How much do you like mathematics	Percent	Percent (s.e.)	Mathematics Achievement	Math. Ach. (s.e.)
Advanced level of final math exam				
Not at all	6	1.2	454	17.2
Sometimes	26	2.1	485	8.3
Almost always	43	2.1	535	6.0
Very much	25	2.0	555	9.0
Basic level of final math exam				
Not at all	27	1.7	411	5.2
Sometimes	46	1.8	430	4.7
Almost always	20	1.4	465	5.9
Very much	7	0.6	495	8.0

Students who choose the advanced level of the mathematics exam achieved higher scores. Even more, 80 % of these students almost always or very much like mathematics. The opposite is 73 % of students who choose basic level of mathematics matura exam and do not like mathematics at all or only sometimes. 25 % of students taking the advanced level of the exam and like mathematics very much in Slovene TIMSS Advanced population came to 2.5 % of the total Slovene age cohort which placed them on the TIMSS Advanced scale between highest achieving Russian Federation and the second on the list, The Netherlands, by coverage index and achievement.

Slovene students who plan to study mathematics, science, computer science and engineering cover 43 % of all gymnasia students or 17 % of age cohort. Those who choose the advanced level of the final math exam, show a higher achievement than students who choose the basic level independently of the area of study as shown in table 3. Students who plan to study mathematics, health science, science, computer science and engineering (69 % in TIMSS sample) made up 27.9 % of age cohort. The mean math achievement of their subgroup of students taking the advanced level of final math exam, covering 7.3 % og age cohort, was calculated to be 539 points, enough for the fourth place on TIMSS Advanced country ranking.

Table 3: Achievement of students according to their intended area of study

INTENDED AREA OF STUDY	Percent	Percent (s.e.)	Mathematics achievement	Math. Ach. (s.e.)

Advanced level of final math exam				
SCIENCE	20.01	2.47	533.35	11.44
HEALTH SCIENCES	20.24	1.96	536.49	8.95
ENGINEERING	16.42	1.90	533.24	12.18
BUSINESS	4.49	1.27	503.41	13.19
COMPUTER AND INFORMATION SCIENCES	5.52	1.38	541.74	17.72
MATHEMATICS	6.86	1.33	573.88	11.47
SOCIAL SCIENCES	21.00	1.80	484.44	9.17
OTHER FIELD OF STUDY	5.46	1.22	500.76	17.55
Basic level of final math exam				
SCIENCE	11.35	1.02	456.69	8.17
HEALTH SCIENCES	4.45	.63	473.26	17.07
ENGINEERING	12.06	1.34	462.72	7.03
BUSINESS	14.35	1.44	420.23	9.72
COMPUTER AND INFORMATION SCIENCES	5.38	.66	457.32	8.22
MATHEMATICS	1.89	.33	491.12	16.27
SOCIAL SCIENCES	38.75	1.90	426.32	6.07
OTHER FIELD OF STUDY	11.78	1.05	414.87	8.04

The national study of comparisons between final grades of mathematics in school, grades at the final math exam and achievement in TIMSS (Cankar, Japelj, 2010) has shown that grades from mathematics and TIMSS achievement are not strongly connected. Girls with similar achievement in TIMSS Advanced as boys obtained in school mathematics almost one grade higher than boys. Therefore, school grades contain an additional view of mathematics achievement which favors girls. Students, who have the two best grades from mathematics in school, very good or excellent (about 40 % of gymnasia students or 16 % of age cohort) reached more TIMSS score points than students with lower grades, but excellent-graded girls have achievement closer to achievement of boys graded with very good rather than excellent. The results are shown in table 4.

Table 4A: Achievement of students by level of math exam according to their grades from mathematics in schools

Grade for mathematics in grade 12	Percent	Percent (s.e.)	Mathematics achievement	Math. Ach. (s.e.)
Advanced level of final math exam				
Sufficient	11.43	2.30	449.72	11.87
Good	20.03	2.13	479.78	5.82
Very good	33.81	2.37	534.19	5.94
Excellent	34.73	3.46	561.96	7.72
Basic level of final math exam				
Insufficient	0.79	0.36	377.72	20.24
Sufficient	41.15	1.67	411.07	5.27
Good	35.80	1.47	441.77	3.87
Very good	17.44	1.43	468.99	8.32
Excellent	4.81	0.77	493.13	12.02

Table 4B: Achievement of students by gender according to their grades from mathematics in schools

Grade for mathematics in grade 12	Percent	Percent (s.e.)	Mathematics achievement	Math. Ach. (s.e.)
Girls				
Insufficient	0.50	0.23	366.30	33.58
Sufficient	32.40	2.08	405.72	6.71
Good	32.08	1.44	438.27	4.89
Very good	23.16	1.48	481.13	8.00
Excellent	11.86	1.48	528.63	8.90
Boys				
Insufficient	0.72	0.58	389.64	18.55
Sufficient	35.45	2.05	426.03	6.87
Good	31.52	1.69	461.32	5.49
Very good	19.12	1.74	520.19	7.68
Excellent	13.19	1.93	560.37	8.80

Boys with excellent grades from mathematics have achievement similar to the mean achievement of the Russian Federation's TIMSS Advanced student population. Their coverage index is 2.1 %, a little higher than coverage index of the Russian Federation population of advanced mathematics students and confirm the belief that small specific groups of students in the huge Slovene TIMSS Advanced population reach a very high TIMSS achievement inside general mathematics curriculum.

Clustering on the basis of student background factors

The best clustering solution consists of ten clusters of students. From cluster characteristics the general descriptions for groups of students assigned to each cluster were drawn and summaries are given in table 5[1].

In our analysis, students were often similar through three main sets of variables: the importance of reasons to choose the level of the final math exam; student opinion of what makes a good mathematics teacher and parental support. Latest two were collected by nationally added questions. The international question for students of how important were some reasons when making the decision about enrollment into their mathematics program was in Slovenia adapted to ask students about the importance of reasons for choosing the level of their final mathematics exam.

1 Extended reports on characteristics of clusters are in Appendix.

In the field trial study of TIMSS Advanced, we asked students to list the five most important characteristics of good mathematics teacher in their opinion. In the main study, the most frequently listed characteristics from the field trial were used to ask students how important they feel specific characteristics are for being good mathematics teacher. Questions and analysis were approved by the national board of expert teachers. The students evaluated teachers in general as having many characteristics of good mathematics teachers. The differences found amongst clusters included the level of importance of some teacher characteristics appreciated by students. Almost all students in all clusters highly appreciate good explanation of content from teachers. That supports the belief that learning mathematics in Slovenia is based on teacher explanations in classes. Additionally, teachers who give additional explanations and examples or adapt the speed of their explanation to suit the students' needs were found to be more appreciated in clusters with less successful students.

Parental support to students is often discussed and promoted in the Slovene school system. We asked students about their relationship with their parents with questions already used in some other national studies. From the agreement of students to the statement "Parents like me very much", we assessed the general support of parents for students, the agreement with the statement "Parents encourage my school work" gives information about the support of parents for student education and the agreement with "Parents think I am smart" tells us about the general perception of student success by parents. Agreement with all three statement was measured by four categories, totaly agree, agree, disagree, totaly disagree.

Table 5: Clusters of students based on student background

Cluster	**Summary of cluster characteristics**	**Description of cluster**
Cluster 1	Students with missing values for majority of variables.	Missing values
Cluster 2	Students who take the basic level of final mathematics exam and who do not take physics as an optional subject at the final exam. They require their teacher to give them examples of items which they should know how to solve. They report that the very important reasons for choosing the level of the mathematics exam were positive attitudes toward mathematics, doing well in mathematics and enjoy solving mathematical problems. Since they choose the basic level, it can be assumed that they do not enjoy mathematics. Half of them were not motivated to work hard on TIMSS test, they only sometimes like mathematics. The proportion of girls and boys is similar to the whole population.	Less motivated student for learning mathematics.
Cluster 3	Students in cluster 3 are almost all girls with high percentages of them having excellent grades for mathematics and physics in elementary school (grade 8). They do not take physics for an optional subject in the final examination but almost two thirds of them take the advanced level of the mathematics exam. They are strongly supported by parents. They enjoy mathematical problems and have positive attitudes toward mathematics, these were the main reasons to choose the advanced level of the mathematics exam. 60% of them always like mathematics and admitted that they worked hard on TIMSS test.	Highly successful and motivated girls for doing mathematics with strong support from parents.

Cluster 4	Students in cluster 4 are similar in their expectations of good mathematics teachers. More than 90% of them thought that it is very important that the teacher gives good additional explanations and examples, is fair and provides clear grading criteria. The teacher should also adapt the speed of their explanations to suit the students' needs and provide a list of examples of items students should know how to solve. In addition, for 87% of students (the highest percentage of all clusters) it is very important for good teacher to have authority. A large majority of students take the basic level of the final mathematics exam but not physics also because this take less time and they have a good teacher for preparing them for basic level of math exam. Students have active support from parents. More than 60% agree that parents like them very much and also that parents encourage them to study. It seems that students in this cluster are passive learners as they rely more on the teacher's capabilities to teach them than on their own learning. They shift responsibility for their mathematics knowledge onto the teachers and, to some extent, onto their parents.	Passive learners with high demands of teachers and support from parents.
Cluster 5	Students in cluster 5 who didn't take physics or the advanced level of the final mathematics exam exceeded 90 %. Over 90% of students also required from good teacher to give additional explanations and examples and adapt the speed of their instructions to suit the students' needs. 60% of students chose the basic level of the final mathematics exam because of their (lower) grades. More than 75 % admitted that they could try harder on TIMSS test and 60 % disagree that they tried hard. Around half of them reported that they put the same effort in the TIMSS tests as they do for tests in school. Therefore, these students were not prepared to work hard for their mathematics education.	Less successful students, with neutral attitudes to mathematics who are not prepared to work hard for mathematics.
Cluster 6	Students in cluster 6 were not taking the advanced level of the final mathematics exam or physics. They reported that in choosing the level of final exam, interest in mathematics, attitudes toward mathematics or having a good teacher were not important – the only important reasons for half of these students were grades and the possibility to easily pass the test. Their grades for mathematics from elementary school were not the highest and 62 % of these students only partially agreed that their parents think they are smart.	Students not interested in mathematics, who choose the basic level of the final mathematics exam just to easily pass the test.
Cluster 7	Cluster 7 consists of a clearly defined population of interested boys who are good at physics but not at mathematics. 91% take physics as an optional subject in the final examination but 76% do not take the advanced level of the mathematics exam. 58% had excellent grades from physics in elementary school and half of them from mathematics. 78% of students has his own computer.	Successful physics students.
Cluster 8	Students in this cluster are overall successful. More than 90% had excellent grades for mathematics and physics in elementary school (grade 8) and take the advance level of the final mathematics exam in grade 12 and 73% also take physics as an optional subject in the final examination. Almost 70% of students have their own computer and are totally convinced that their parents think they are smart. Two thirds are boys and the same percentage admit that they choose the advanced level of the mathematics exam because they are doing well in mathematics and have positive attitude toward mathematics.	Most successful mathematics students.

Cluster 9	Students in cluster 9 are weak mathematics students who admit that they do not like mathematics - 75% of them report that they totally disagree with the statement "I like mathematics." 73% of students expect to get the lowest positive grade, sufficient, for mathematics in grade 12. 96% of them do not take the advanced level of the final mathematics exam and 94% do not take physics. As for good teachers, 87% of students expect them to be fair and to adapt the speed of their explanation to suit the students' needs. Students describe that having an interest in mathematics is very unimportant for choosing the advanced or the basic level of the final exam.	Students with the lowest grades for mathematics.
Cluster 10	Students in cluster 10 are most similar in their expectations of a good mathematics teacher. For more than 90% of the students, for a teacher to be rated as good, it is very important that the teacher gives additional explanations, adapt the speed of their explanation to suit the students' needs. The teacher should also be fair and for more than 80% of the students, it is very important that each teacher has authority and provides clear grading criteria. Having a good teacher was a very important reason for choosing the level of final the mathematics exam. The highest percentage of students compared to other clusters reported high parental support with 80% saying that parents like them very much and almost 60% of student said that their parents actively encourage them in their work for school. Only one third of students take the advance level of the final math exam and one quarter physics. The main difference in characteristics from cluster 4 is that in cluster 10, students express higher self-confidence. Almost 70% of students strongly agree that their parents think they are smart while in cluster 4, only 61% only agree that their parents think they are smart.	Students with high expectations of a good teacher with strong support from parents and high self-confidence.

In the final step, we linked clustering to achievement in TIMSS. As shown in table 6, students in cluster 8 have the mean achievement much higher than mean achievements of students in other clusters.

Table 6: TIMSS Advanced Mathematics Achievement by clusters based on student characteristics

Cluster	Percent	Percent (s.e.)	Mathematics Achievement	Math. Ach. (s.e.)
1	1.44	0.42	418.19	17.78
2	12.60	0.68	445.96	6.20
3	10.69	1.01	506.36	6.68
4	10.02	0.66	447.71	6.97
5	15.84	1.00	429.70	5.01
6	15.84	1.20	419.98	5.51
7	8.71	1.10	483.93	7.29
8	8.35	0.80	567.68	6.59
9	8.63	0.78	394.22	8.43
10	7.89	0.64	482.29	9.77

In table 6, the size of clusters can be seen from the percentage of students assigned to clusters. Cluster 1 contains small percentage of all TIMSS Advanced students who had missing values for variables of student background. By multiplying the percentage of students in a cluster with the mathematics coverage index for sample of TIMSS Advanced, 40.5 %, the coverage index of the group of students forming a cluster in the whole age cohort can be estimated. Therefore, Cluster 8 covers 3.38 % percentages of all Slovene students of the appropriate age cohort which is

comparable to the Netherlands' coverage index of 3.5 % and larger than the coverage index of the Russian Federation, 1.4 %.

According to our expectations, students in cluster 8, described as higher achievers, reached the largest score which is 567 points on TIMSS Advanced achievement scale. Achievement is statistically similar to the mean achievement of the first country on TIMSS Advanced scale, the Russian Federation and significantly higher than the mean achievement of the second country on the international scale, the Netherlands.

Cluster 8 students overlapped significantly with students who chose the advanced level of mathematic and physics as an optional subject in the final examination at the end of grade 12. The percentage of these students in the TIMSS Advanced population was 9.8 % and 4.0 % in the general population of students of the appropriate age (or coverage index). They achieved 548 score points on TIMSS Advanced test for mathematics, which would place them between the Netherlands and Lebanon on the TIMSS scale and were not significantly different from both. Student from cluster 8 differ from these students in their high motivation for advanced math so lower achievement was expected.

If students with characteristics from cluster 8 are included in the more advanced mathematics program in school, this program should be oriented to specific areas of the students' future university studies. Table 8 shows percentages and achievement of students in cluster 8 by their intended areas of study.

Table 8: Percentages and achievement of students in cluster 8 by their intended areas of university study

Area of study	Percent	Percent (s.e.)	Mathematics Achievement	Math. Ach. (s.e.)
SCIENCE	22.47	3.79	579.75	14.60
HEALTH SCIENCES	22.51	4.02	567.73	12.92
ENGINEERING	24.77	3.01	565.30	9.76
BUSINESS	2.08	1.56	561.36	28.84
COMPUTER AND INFORMATION SCIENCES	6.28	2.34	592.05	16.97
MATHEMATICS	11.47	2.75	607.34	14.10
SOCIAL SCIENCES	7.52	1.84	522.39	17.85
OTHER FIELD OF STUDY	2.89	1.78	564.52	35.28

A high percentage of students from cluster 8 want to study science, health science and engineering as well as mathematics but not business nor social science. The highest achievement have future mathematicians and computer specialists. Health studies have the highest limitations in the number

of accepted students so candidates compete hard for entrance with all possibilities. The final matura grade is of vital importance and taking advanced level of final math exam increase it. Other popular studies for students from cluster 8 have no entrance limitations but have at least a one year mathematics course - so students need strong mathematical knowledge from gymnasia. From the intention for study, it may be concluded that students from cluster 8 would, by and large, benefit from a more advanced mathematics course in secondary school for their future study at university.

Clustering of students by their learning environment

Accepted clustering solution for grouping students by their actual learning environment gave also good results. Ten clusters of students differ mostly by the level of preparation of teachers for teaching and by characteristics that students have confirmed teachers have from a set of characteristics defining a good teacher in students' view.

Table 9: Description of characteristics of clusters of TIMSS Advanced students from Slovenia by learning environment factors

Cluster	Short description of characteristics
Cluster 1:	Teachers are less well prepared for teaching. Schools do not encourage students to take advanced level of mathematics final exam.
Cluster 2:	Students never use any computer technology and report math lessons are boring.
Cluster 3:	Teacher are very well prepared for teaching. More than 90 % of students have teacher explaining contents well and give a lot of emphasis to informal assessment of students progress. Teacher expectations for student knowledge are high for more than 60 % of students. Students use computers and need 1 hour to do homework in comparison to average 30 minutes in other groups. Half of students are not encouraged by school to take advanced level of math exam.
Cluster 4:	Half of students said teacher has no authority, and 45 % students reported that teachers have no clear grading criteria or are fair. Half of students in half of lesson are asked to read theory from textbooks. Half of them use computers at some lessons. Teachers of students in this cluster reported being limited in teaching by different student factors: different academic abilities of students, high student-teacher proportion, student who skip classes and tests as well as student who are not interested in mathematics. But half students have teachers who are very satisfied with their work.

Cluster	Short description of characteristics
Cluster 5:	Almost all students have very well prepared teachers to teach and 70 % of them have teachers satisfied with their work. More then 80 % of students have fair teachers with authority. More than 90 % of students never use computers or read theory from textbooks. Almost two thirds of students are never asked to learn facts or procedure by heart in lessons or for homework. Almost 80 % of students are only at some lessons asked to decide by themselves how to solve problems.
Cluster 6:	All students have extremely well prepared teachers who participated in professional development courses about math curriculum. Half of students do use the most demanding textbook available for secondary school programs. All students are not encouraged to take advanced level of math exam by their schools. Students never use computers and are never asked to learn something by heart. 94 % students reported that their teacher has authority but almost one third of students report that teachers do not explain the content well. Half of students report that teachers do not adapt speed of explanation to students' needs.
Cluster 7:	Students with mostly missing values.
Cluster 8: Well prepared teacher with all characteristics of good teachers; Homework every lesson, rare computer use, not boring lessons. Valued student work for mathematics outside the school.	All students reported to have very good prepared teachers for teaching and confirmed that their teacher explains the content well, has authority, is fair and has clear grading criteria. Teachers of more than 90 % of students takes into account the student work for mathematics outside school lessons, always gives homework, always as set of exercises and never to find the use of mathematics or work with data. 73 % students finish homework in less then 30 minutes and have teachers who adapt speed of explanation to students' needs. Teachers of more then 80 % of students participated in training programs about math content and use of ICT but only half of students in some lessons use computer. More than two thirds of students never use computer or calculator for modeling, solving equations or algebraic expressions. More than 65 % students every lesson listen to teacher explanations and never have to read textbook in lessons or for homework. 57 % of students admitted that they have not the best relationship with teachers, but for half students mathematics lesons are not boring. More than half of students agree that their teacher is preparing them well for final exam, get students like to work on math problems, and make student feel successful. Teachers of half of students have very high expectations to students achievement.
Cluster 9:	Teachers of all students are very well prepared for teaching but their satisfaction with work is not very high. Teachers of more than 80 % of students explain content well, has authority and gives additional explanations. But teachers of 91 % students feel very limited in teaching because students do not have homework done, teachers of 78 % of students feel very limited by not interested students and more than 60 % of students have teacher reporting to be limited in teaching by large number of students in class and their different academic abilities. 87 % of students never use computers and never read textbooks. For homework they are never asked to do something different from exercises or problem sets. Teachers of more than half of students do not participate in professional development programs.

Cluster	Short description of characteristics
Cluster 10:	All students in this cluster have teachers with the highest self-confidence. All teachers said they are extremely well prepared for teaching all contents and do not participate in any professional development program. Their satisfaction with work is not high. More than 90 % of students confirm that teachers have authority. 80 % of students said teachers explain content well and have clear grading criteria. No student ever get homework, 66 % of them never need to memorize formulas and teacher do not test student knowledge regularly. Half of the students are never asked by teacher to learn something by heart. For half of the students, teachers have low expectations of student knowledge.

Mean achievement of students in clusters show significant differences. The highest achievement was observed in cluster 8 as shown in table 9.

Table 9: Mathematics Achievement of students in clusters by learning environments

Clusters	Percent	Percent (s.e.)	Mathematics Achievement	Mat. Ach. (s.e.)
1	14.63	4.37	448.36	9.74
2	18.00	2.77	431.96	7.45
3	15.39	4.59	453.86	13.14
4	6.27	2.31	452.59	11.76
5	13.60	3.33	478.60	11.82
6	2.91	1.74	412.13	7.88
7	3.56	2.20	469.20	27.45
8	12.46	3.56	504.16	12.06
9	12.06	3.22	448.63	16.82
10	1.12	0.05	455.12	27.00

The highest mathematics achievement of students in cluster 8 support the high importance of teacher background together with approaches to teaching for students knowledge. Teachers in cluster 8 demonstrate hard and devoted work for students and students obviously appreciate good and very demanding teachers.

Conclusion

The general mathematics curriculum in Slovenia is demanding. But, at the end of secondary school, students can decide to pass only the basic level of math exam and are therefore required to demonstrate mostly the applications of math content only (i.e. calculate the limit of a function). The whole coverage of mathematics theory should demonstrate only students taking the advanced level of the final math exam (i.e. understanding the “epsilon” definition of the limit). Even if the curriculum is required to be covered, majority of teachers admited that their basis for teaching is the Catalogue of standards of knowledge required for basic or advanced math matura exam, chosen according to the average decision about the level of the final math exam taken by students in the class. That means that many students do not get the opportunity to learn theoretical mathematics. Discussed, more advanced math program should therefore offer to motivated students to systematically learn theorethical mathematics for more years during their everyday lessons, at least in the extent of the required standards of knowledge for the advanced level of mathematics matura exam.

By clustering, we were successful in finding the group of candidates for more advanced mathematics in Slovenia. They are students, who decide to take the advance level of the final mathematics exam, choose physics as one of two compulsory optional subjects for the final examination, are recognized as smart and are motivated for learning mathematics. They also intend to choose mathematically demanding university studies. Their achievement was found to be very high, the highest among other countries on the international TIMSS Advanced scale. It can be assumed that these students would choose a more advanced program of mathematics in school if such a program exists.

By clustering we also discovered some characteristics of student learning environment in Slovenia which most likely help to higher mathematical knowledge. Well educated, demanding but devoted teachers with high expectations of student knowledge, who explain the content well enough that students do not need to learn it from other sources such as textbooks are most important factors. The use of ICT seems not to be important for better students results in mathematics as much as regular short homework and tests. With such results, teachers do not need to fear that they are not characterized as good teachers by their students if they expect and ask a lot from students or avoid the daily use of ICT.

Finaly, but important for our school system, we also confirmed that special population of Slovene future students of science, engineering, mathematics and computer science achieved very high

results on TIMSS tests, comparable to the achievement of leading countries on TIMSS Advanced scale.

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Appendix - Clustering report: Characteristics of cluster by student background

(In the first column are percentages of students in the cluster with the corresponding variable value.)

Characteristics for the cluster 1: missing values

Characteristics for the cluster 2:

98.48 % ms2gcsri (when use computer\researching) = yes
87.12 % csnmatl1 (preparing for matura at advanced level) = no
86.74 % csngrph3 (expected physics grade in 12th grade) = missing
86.36 % csncha12 (characteristics of good math teacher/provide list of items we should know to solve) = important
85.98 % msdmpatm (std reason/positive affect toward math) = important
85.98 % ms2mphco (have physics for matura) = no
85.23 % csnchar1 (characteristics of good math teacher/explain content well) = very important
84.47 % ms2mwswm (mat\why study\well in mathematics) = important
79.92 % ms2mwsec (mat\why study\enjoy solving math problems) = important
76.89 % csncha11 (characteristics of good math teacher/clear grading criteria) = important
74.24 % csncha14 (characteristics of good math teacher/regularly test knowledge) = important
72.73 % csnpare1 (parents think i am smart) = agree
71.21 % csnchar7 (characteristics of good math teacher/have authority) = important
70.83 % ms2mwsmi (mat\why study\math interesting) = important
69.32 % ms2mwsep (mat\why study\easily pass test) = important
67.05 % msdmgtt (std reason/good teacher and teaching) = important
65.15 % csnpare3 (parents encourage learning) = agree
64.39 % csncha13 (characteristics of good math teacher/regularly gives homework) = important
63.26 % ms2mwslt (mat\why study\not take a lot time) = important
62.88 % csngrade (reason for chosen level of matura/grades) = important
61.36 % itsex (sex of student) = girl
60.23 % csnchar6(characteristics of good math teacher/include examples from everyday life) = important
60.23 % msdmafo (std reason/advice from others) = unimportant
59.09 % csntims3 (solving TIMSS test: i work as hard as for tests in school) = agree
57.58 % csnpare6 (parents think grades are very important) = agree

56.82 % csntims6 (when solving TIMSS: i could try harder) = agree
54.92 % csnpare4 (parents like me very much) = agree
54.55 % csntims1 (when solving TIMSS - i tried hard) = agree
53.41 % csnchar5(characteristics of good math teacher/give additional explanations and examples) = very important
53.41 % ms2mwsmo (mat\why study\more options to choose study) = important
53.41 % ms2mwsgt (mat\why study\good teacher) = important
51.89 % csngrma1 (math grade/9th grade of elementary school) = odlicno
51.52 % csnchar3 (characteristics of good math teacher/adapt speed of explanation to students needs) = important
51.52 % csnlikem (i like math) = sometimes
50.76 % csnpare2 (parents help with schoolwork) = disagree
50.76 % ms2gth03 (have own computer) = no
50.38 % csntims5 (when solving TIMSS: I was motivated to do my best) =disagree
50.00 % ms2mwspc (mat\why study\pursue career) = important

Characteristics for the cluster 3:
98.25 % csnchar1 (characteristics of good math teacher/explain content well) = very important
96.93 % ms2gcsri (when use computer\researching) = yes
90.79 % csnchar5(characteristics of good math teacher/give additional explanations and examples) = very important
89.91 % csngrph1 (physics grade/9th grade of elementary school) = excellent
89.91 % ms2mphco (have physics for matura) = no
89.47 % csnchar3 (characteristics of good math teacher/adapt speed of explanation to students needs) = very important
89.04 % itsex (sex of student) = girl
88.60 % csnchar8 (characteristics of good math teacher/fair) = very important
88.16 % csngrma1 (math grade/9th grade of elementary school) = odlicno
71.05 % csnchar7 (characteristics of good math teacher/have authority) = very important
67.11 % csnpare4 (parents like me very much) = totaly agree
66.23 % ms2mwsec (mat\why study\enjoy solving math problems) = important
64.47 % msdmpatm (std reason/positive affect toward math) = important
62.28 % ms2mwsep (mat\why study\easily pass test) = important
62.28 % csnlikem (i like math) = mostly
61.84 % csntims1 (when solving TIMSS - i tried hard) = agree
60.53 % csnmatl1 (preparing for matura at advanced level) = yes
60.53 % ms2mwswm (mat\why study\well in mathematics) = important
57.46 % csncha11 (characteristics of good math teacher/clear grading criteria) = very important
56.14 % msdmafo (std reason/advice from others) = unimportant
55.70 % csncha14 (characteristics of good math teacher/regularly test knowledge) = important
55.70 % ms2mwsmi (mat\why study\math interesting) = important
55.70 % csntims4 (when solving TIMSS: I kept solving each item to the end) = agree
53.95 % csnchar6(characteristics of good math teacher/include examples from everyday life) = important
53.95 % ms2gth03 (ihave own computer) = no
53.51 % ms2gtusc (time of using computer) = less than 1 hour
53.51 % ms2gstuc (time using computer) = less than 1 hour
53.07 % csnpare1 (parents think i am smart) = totaly agree
51.75 % csngrade (reason for chosen level of matura/grades) = important
51.75 % csncha12 (characteristics of good math teacher/provide list of items we should know to solve) = very important
51.32 % csnpare6 (parents think grades are very important) = agree

Characteristics for the cluster 4:
97.30 % csnchar5(characteristics of good math teacher/give additional explanations and examples) = very important

96.85 % ms2gcsri (when use computer\researching) = yes
95.95 % csnchar1 (characteristics of good math teacher/explain content well) = very important
95.95 % csnchar8 (characteristics of good math teacher/fair) = very important
92.34 % csncha11 (characteristics of good math teacher/clear grading criteria) = very important
92.34 % csnchar3 (characteristics of good math teacher/adapt speed of explanation to students needs) = very important
91.44 % csncha12 (characteristics of good math teacher/provide list of items we should know to solve) = very important
87.84 % msdmpatm (std reason/positive affect toward math) = important
86.94 % csnchar7 (characteristics of good math teacher/have authority) = very important
86.94 % csnchar6(characteristics of good math teacher/include examples from everyday life) = very important
83.78 % ms2mwswm (mat\why study\well in mathematics) = important
81.98 % csnmatl1 (preparing for matura at advanced level) = no
79.73 % ms2mwsmi (mat\why study\math interesting) = important
78.83 % ms2mwsec (mat\why study\enjoy solving math problems) = important
75.68 % ms2mwsep (mat\why study\easily pass test) = important
75.23 % csngrph3 (expected physics grade in 12th grade) = missing
75.23 % ms2mwslt (mat\why study\not take a lot time) = important
74.77 % msdmgtt (std reason/good teacher and teaching) = important
74.32 % ms2mphco (have physics for matura) = no
71.17 % ms2gth03 (have own computer) = yes
66.22 % ms2mwsgt (mat\why study\good teacher) = important
63.96 % ms2mwsmo (mat\why study\more options to choose study) = important
63.06 % csngrade (reason for chosen level of matura/grades) = important
61.26 % csnpare1 (parents think i am smart) = agree
60.36 % csnpare3 (parents vzpodbujajo k ucenju) = agree
59.91 % csnpare4 (parents like me very much) = totaly agree
59.46 % ms2mwspc (mat\why study\pursue career) = important
57.66 % csncha13 (characteristics of good math teacher/regularly gives homework) = very important
55.86 % csncha14 (characteristics of good math teacher/regularly test knowledge) = very important
53.15 % csntims1 (when solving TIMSS - i tried hard) = agree
51.80 % csntims6 (when solving TIMSS: i coud try harder) = agree
51.35 % csnpare6 (parents think grades are very important) = agree
50.45 % itsex (sex of student) = boy
50.00 % msdmafo (std reason/advice from others) = unimportant

characteristics for the cluster 5:
97.83 % csnchar1 (characteristics of good math teacher/explain content well) = very important
97.20 % ms2gcsri (when use computer\researching) = yes
92.86 % ms2mphco (have physics for matura) = no
92.86 % csnmatl1 (preparing for matura at advanced level) = no
92.55 % csnchar5(characteristics of good math teacher/give additional explanations and examples) = very important
90.99 % csnchar3 (characteristics of good math teacher/adapt speed of explanation to students needs) = very important
88.82 % csnchar8 (characteristics of good math teacher/fair) = very important
85.71 % itsex (sex of student) = girl
75.47 % csntims6 (when solving TIMSS: i could try harder) = totaly agree
71.12 % csncha12 (characteristics of good math teacher/provide list of items we should know to solve) = very important
67.08 % csnpare4 (parents like me very much) = totaly agree
63.66 % csntims2 (when solving TIMSS: i was not totaly focused) = agree
63.66 % csnchar7 (characteristics of good math teacher/have authority) = very important
63.04 % csncha11 (characteristics of good math teacher/clear grading criteria) = very important

61.80 % csntims4 (when solving TIMSS: i kept trying to the end) = disagree
60.25 % csntims1 (when solving TIMSS - i tried hard) = disagree
59.94 % csngrade (reason for chosen level of matura/grades) = zelo important
58.07 % csntims5 (when solving TIMSS: I was motivated to do my best)= disagree
55.59 % csnlikem (I like math) = sometimes
55.28 % ms2gth03 (have own computer) = yes
53.73 % ms2mwsmi (mat\why study\math interesting) = important
50.31 % ms2mpret (mat\prepare for test) = about once a month
50.00 % csntims3 (solving TIMSS test: i work as hard as for tests in school) = totaly agree
50.00 % csngrph1 (physics grade/9th grade of elementary school) = excellent

Characteristics for the cluster 6:
97.28 % ms2gcsri (when use computer\researching) = yes
93.35 % csnchar1 (characteristics of good math teacher/explain content well) = very important
91.24 % csnmatl1 (preparing for matura at advanced level) = no
90.33 % ms2mphco (have physics for matura) = no
86.10 % msdmpatm (std reason/positive affect toward math) = unimportant
80.66 % csnchar5(characteristics of good math teacher/give additional explanations and examples) = very important
80.36 % ms2mwsec (mat\why study\enjoy solving math problems) = unimportant
79.15 % csnchar3 (characteristics of good math teacher/adapt speed of explanation to students needs) = very important
76.44 % ms2mwsmi (mat\why study\math interesting) = unimportant
76.44 % csnchar8 (characteristics of good math teacher/fair) = very important
69.49 % ms2mwswm (mat\why study\well in mathematics) = unimportant
63.44 % ms2mwsmo (mat\why study\more options to choose study) = unimportant
63.14 % ms2gth03 (have own computer) = yes
62.54 % msdmafo (std reason/advice from others) = unimportant
62.24 % csnlikem (I like math) = sometimes
61.93 % csnpare1 (parents think i am smart) = agree
60.73 % csncha14 (characteristics of good math teacher/regularly test knowledge) = important
58.61 % itsex (sex of student) = girl
57.40 % csncha13 (characteristics of good math teacher/regularly gives homework) = important
55.89 % csnpare3 (parents encourage learning) = agree
54.98 % ms2mwsgt (mat\why study\good teacher) = unimportant
54.98 % csntims6 (when solving TIMSS: i could try harder) = agree
54.38 % ms2mwsep (mat\why study\easily pass test) = important
53.78 % ms2mwslt (mat\why study\not take a lot time) = unimportant
53.17 % csntims3 (solving TIMSS test: i work as hard as for tests in school) = agree
52.27 % csngrma1 (math grade/9th grade of elementary school) = very good
51.66 % csncha11 (characteristics of good math teacher/clear grading criteria) = important
51.66 % csntims1 (when solving TIMSS - i tried hard) = agree
51.06 % ms2mwspc (mat\why study\pursue career) = unimportant
50.45 % csnchar7 (characteristics of good math teacher/have authority) = very important
50.45 % csnpare6 (parents think grades are very important) = agree
50.15 % csnpare4 (parents like me very much) = totaly agree

Characteristics for the cluster 7:
97.22 % ms2gcsri (when use computer\researching) = yes
94.91 % itsex (sex of student) = boy
91.20 % ms2mphco (have physics for matura) = yes
91.20 % csnchar1 (characteristics of good math teacher/explain content well) = very important
78.24 % ms2gth03 (have own computer) = yes
75.93 % csnmatl1 (preparing for matura at advanced level) = no
69.44 % csnchar8 (characteristics of good math teacher/fair) = very important

68.52 % ms2mwswm (mat\why study\well in mathematics) = important
63.89 % csnchar5(characteristics of good math teacher/give additional explanations and examples) = very important
62.04 % csnchar3 (characteristics of good math teacher/adapt speed of explanation to students needs) = very important
59.72 % ms2gstsw (time for schoolwork) = less than 1 hour
58.33 % csngrph1 (physics grade/9th grade of elementary school) = excellent
56.48 % msdmpatm (std reason/positive affect toward math) = important
53.70 % csncha11 (characteristics of good math teacher/clear grading criteria) = important
51.39 % csngrma1 (math grade/9th grade of elementary school) = excellent
50.93 % ms2mwsec (mat\why study\enjoy solving math problems) = important
50.93 % csnpare4 (parents like me very much) = totaly agree
50.93 % msdmgtt (std reason/good teacher and teaching) = important
50.46 % csnpare1 (parents think i am smart) = agree
50.46 % csntims1 (when solving TIMSS - i tried hard) = agree
50.00 % csnchar7 (characteristics of good math teacher/have authority) = very important

Characteristics for the cluster 8:
98.39 % ms2gcsri (when use computer\researching) = yes
94.62 % csngrma1 (math grade/9th grade of elementary school) = excellent
93.55 % csnchar1 (characteristics of good math teacher/explain content well) = very important
91.40 % csngrph1 (physics grade/9th grade of elementary school) = excellent
90.32 % csnmatl1 (preparing for matura at advanced level) = yes
73.66 % ms2mphco (have physics for matura) = yes
69.35 % ms2gth03 (have own computer) = yes
68.82 % csnchar3 (characteristics of good math teacher/adapt speed of explanation to students needs) = very important
68.28 % csnpare1 (parents think i am smart) = totaly agree
67.74 % itsex (sex of student) = boy
66.13 % ms2mwswm (mat\why study\well in mathematics) = very important
65.05 % csnpare4 (parents like me very much) = totaly agree
62.90 % msdmpatm (std reason/positive affect toward math) = very important
61.29 % csnchar5(characteristics of good math teacher/give additional explanations and examples) = very important
58.60 % csncha14 (characteristics of good math teacher/regularly test knowledge) = important
58.06 % csntims2 (when solving TIMSS: I was not totaly focused) = disagree
57.53 % csnchar8 (characteristics of good math teacher/fair) = very important
56.45 % csncha12 (characteristics of good math teacher/provide list of items we should know to solve) = important
55.91 % csncha11 (characteristics of good math teacher/clear grading criteria) = important
55.91 % csngrph2 (physics grade/3rd grade of secondary school) = odlicno
55.38 % csngrma3 (expected math grade in 12th grade) = odlicno
55.38 % csntims4 (when solving TIMSS: i kept working on each item to the end) = agree
54.84 % csntims1 (when solving TIMSS - i tried hard) = agree
53.23 % csnchar7 (characteristics of good math teacher/have authority) = important
52.15 % ms2mwsmi (mat\why study\math interesting) = important
52.15 % ms2mwsep (mat\why study\easily pass test) = important
51.08 % ms2mwsec (mat\why study\enjoy solving math problems) = important

Characteristics for the cluster 9:
96.30 % csnmatl1 (preparing for matura at advanced level) = no
95.77 % ms2gcsri (when use computer\researching) = yes
94.71 % csnchar1 (characteristics of good math teacher/explain content well) = very important
92.06 % ms2mphco (have physics for matura) = no
87.30 % csnchar8 (characteristics of good math teacher/fair) = very important
86.77 % csnchar3 (characteristics of good math teacher/adapt speed of

explanation to students needs) = very important
86.24 % csnchar5(characteristics of good math teacher/give additional explanations and examples) = very important
84.66 % ms2mwspc (mat\why study\pursue career) = very unimportant
84.66 % msdmpatm (std reason/positive affect toward math) = very unimportant
78.84 % ms2mwsec (mat\why study\enjoy solving math problems) = very unimportant
74.60 % csnlikem (i like math) = not at all
74.07 % ms2mwsmi (mat\why study\math interesting) = very unimportant
73.02 % csngrma3 (expected math grade in 12th grade) = sufficient
70.90 % msdmafo (std reason/advice from others) = very unimportant
67.72 % ms2mwsmo (mat\why study\more options to choose study) = very unimportant
63.49 % csncha12 (characteristics of good math teacher/provide list of items we should know to solve) = very important
62.96 % csnpare4 (parents like me very much) = totaly agree
62.43 % csnchar6(characteristics of good math teacher/include examples from everyday life) = very important
61.38 % ms2mwswm (mat\why study\well in mathematics) = very unimportant
60.32 % ms2gth03 (have own computer) = yes
59.79 % ms2mwslt (mat\why study\not take a lot time) = very unimportant
58.73 % csncha11 (characteristics of good math teacher/clear grading criteria) = very important
58.20 % csnchar7 (characteristics of good math teacher/have authority) = very important
55.03 % ms2mwsgt (mat\why study\good teacher) = very unimportant
54.50 % ms2giaos (intended area of study) = social sciences
54.50 % itsex (sex of student) = girl
51.85 % csngrade (reason for chosen level of matura/grades) = very important

Characteristics for the cluster 10:
99.42 % csnchar1 (characteristics of good math teacher/explain content well) = very important
98.84 % ms2gcsri (when use computer\researching) = yes
96.51 % csnchar5(characteristics of good math teacher/give additional explanations and examples) = very important
96.51 % csnchar8 (characteristics of good math teacher/fair) = very important
92.44 % csnchar3 (characteristics of good math teacher/adapt speed of explanation to students needs) = very important
82.56 % msdmgtt (std reason/good teacher and teaching) = very important
81.40 % csnchar7 (characteristics of good math teacher/have authority) = very important
80.23 % csncha11 (characteristics of good math teacher/clear grading criteria) = very important
79.65 % csnpare4 (parents like me very much) = totaly agree
79.07 % csncha12 (characteristics of good math teacher/provide list of items we should know to solve) = very important
77.91 % ms2mwsgt (mat\why study\good teacher) = very important
76.16 % msdmpatm (std reason/positive affect toward math) = very important
72.09 % csngrph3 (expected physics grade in 12th grade) = missing
72.09 % ms2mphco (have physics for matura) = no
68.02 % csnpare1 (parents think i am smart) = totaly agree
65.70 % csnchar6(characteristics of good math teacher/include examples from everyday life) = very important
63.37 % csnmatl1 (preparing for matura at advanced level) = no
62.79 % ms2mwswm (mat\why study\well in mathematics) = very important
62.21 % csncha13 (characteristics of good math teacher/regularly gives homework) = very important
62.21 % ms2gth03 (have own computer) = yes
58.72 % csngrma1 (math grade/9th grade of elementary school) = excellent
58.14 % csnpare3 (parents encourage learning) = totaly agree
57.56 % ms2mwsmi (mat\why study\math interesting) = very important

55.81 % ms2mwsep (mat\why study\easily pass test) = very important
55.23 % csngrade (reason for chosen level of matura/grades) = very important
55.23 % ms2mwslt (mat\why study\not take a lot time) = very important
51.74 % itsex (sex of student) = girl
51.74 % csncha14 (characteristics of good math teacher/regularly test knowledge) = very important
51.16 % csngrph1 (physics grade/9th grade of elementary school) = excellent