2020

Tools Review and Needs Analysis

Intellectual Output 1

MareMathics – Innovative Approach in Mathematical Education for Maritime Students

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Contents

University of Split, Faculty of Maritime Studies

Abstract

Voluntary surveys of mathematics teachers (n = 3) and students (n = 175) were conducted. These surveys were carried out during the summer semester, 2019/2020. academic year. The current research is an attempt to obtain students' and teacher's perspective on the use of math classroom methods and tools as their satisfaction with current teaching and learning process.

In particularly, math teachers were asked to provide their perspective of the use of teaching methods and models of teaching tools in the classroom, student engagement and participation in teaching and learning activities and implementation barriers.

The student survey identified the individual mathematical background of students, their perception of the importance of mathematical skills in their study and for a future job, use of methods and tools for learning and their perception of the teaching process. The results indicated a low level of efficiency in the existing mathematical environment. On the one hand, teachers with traditional static methods and tools have not provided an effective environment for learning mathematics. Students were not interested in teaching mathematics and did not associate mathematical content with meaningful real-world applications. On the other hand, students did not have high mathematical skills and very low motivation and satisfaction with the current teaching process.

1. Introduction

The low rate of student success on mathematical exams can be attributed to their mathematical background. The reasons for the mathematical deficiency of students studying at the University of Split, Faculty of Maritime Studies and Naval Study, are many and various. These can be viewed from several perspectives: the teacher, the student, the high educational institution, the national.

Based on student and teacher feedback, this report concentrates on pursues the factors of low effective math environment which can be considered in the development of useful teaching and learning mathematical materials and tools that can be shared across the maritime high educational community.

Need for this Study

Courses based on mathematics are mostly included in the first year of the bachelor degree at the Faculty of Maritime Studies and Department of Naval Study at the University of Split, Croatia. These courses require students 'active participation both in the classroom and outside of it. The results of student success of passing final exams from these subjects, obtained in the last academic year (2018-2019), are analysed. The number of enrolled students for math courses and statistics and the pass rate of the exams are shown in Table 1.

During the last academic year, the percentage of students that successfully passed the mathematical subject was around 30% of the total number of enrolled students.

Statistics is a mandatory course for students of the following studies: Maritime Yacht and Marina and Maritime Management. Hence, approximately 1/2 of the total number of students successfully passed the exam in Statistics.

Table 1.1. Number and percentage of students who passed the final exam in the mathematical courses and statistics at Faculty of Maritime Studies in Split

Year: 2018./2019.	Mathematics I			Mathematics II			Applied Mathematics in Navigation			Statistics		
Undergraduate studies	**Enrolled students**	**Pass (C)**	**Pass (%)**	**Enrolled students**	**Pass (C)**	**Pass (%)**	**Enrolled students**	**Pass (C)**	**Pass (%)**	**Enrolled students**	**Pass (C)**	**Pass (%)**
Marine Engineering	**95**	**24**	**25%**	**118**	**13**	**17.5%**						
re-enrolled	29	9	31%	47	19	40.4%						
first time	66	15	23%	71	15	21.1%						
Nautical Studies	**203**	**63**	**31%**	**235**	**65**	**27.7%**	**80**	**25**	**31%**			
re-enrolled	88	27	31%	114	32	28.1%	29	7	24%			
first time	115	36	31%	121	33	27.3%	51	18	35%			
Marine Electrical Engineering and Information Technologies	**89**	**29**	**33%**	**108**	**32**	**29.6%**						
re-enrolled	39	9	23%	52	16	30.77%						
first time	50	20	40%	56	16	28.57%						
Maritime Yacht and Marina Technologies	**79**	**22**	**28%**	**87**	**24**	**27.59%**				**46**	**24**	**52%**
re-enrolled	28	8	**29%**	35	12	**34.29%**				18	5	28%
first time	51	14	**27%**	52	12	**23.08%**				28	19	68%
Maritime Management	**108**	**35**	**32%**	**125**	**32**	**25.60%**				**45**	**21**	**47%**
re-enrolled	45	16	**36%**	55	18	**32.73%**				14	5	36%
first time	63	19	**30%**	70	14	**20.00%**				31	16	52%
Grand Total	**574**	**173**	**30%**	**673**	**166**	**30%**	**80**	**25**	**31%**	**91**	**45**	**49%**

Marine Engineering students had poorest pass rates in Mathematics I and Mathematics II exams, 25% and 17.5%, respectively. Students of other studies had approximately similar passing exams, around 30%. It is important to note the large number of students who re-enrolled Mathematics I (40%) and Mathematics II (45%) due to non-passing in the previous academic year.

Students were more successful in the exams in Statistics where the pass rate is about 49%.

Table 1.2. Number and percentage of students who dropped from the study and failed the mathematical courses

Year: 2018./2019.		Mathematics I		Mathematics II		Applied Mathematics in Navigation	
Undergraduate studies	**Dropout rate from the study**	**Non Pass (C)**	**Non Pass (%)**	**Non Pass (C)**	**Non Pass (%)**	**Non Pass (C)**	**Non Pass (%)**
Marine Engineering	**14**	**13**	**93%**	**14**	**100%**		
re-enrolled	3						
first time	11						
Nautical Studies	**15**	**10**	**67%**	**13**	**87%**	**3**	**20%**
re-enrolled	6						
first time	9						
Marine Electrical Engineering and Information Technologies	**10**	**9**	**90%**	**10**	**100%**		
re-enrolled	4						
first time	6						
Maritime Yacht and Marina Technologies	**8**	**7**	**88%**	**8**	**100%**		
re-enrolled	4						
first time	4						
Maritime Management	**10**	**9**	**90%**	**10**	**100%**		
re-enrolled							
first time	10						
Grand Total	**57**	**48**	**84%**	**55**	**96%**	**3**	**5%**

Last academic year 57 students dropped from their study. Within this number of dropped students, most of them didn't pass Mathematics I (84%) and Mathematics II (96%).

2. Report of teacher and student surveys – quantitative analysis

The results presented in this report are based on surveys carried out on the teachers and students participated in teaching or learning process in some of four courses (Mathematics 1, Mathematics 2, Applied Mathematics in Navigation and Statistics) offered in bachelor study programmes at Faculty of Maritime Studies and Naval Study at the University of Split. Two questionnaires were designed: a teacher questionnaire and student questionnaire.

The teacher questionnaire with 35 items covered tools and method applied by math lectures and assistants in the classroom or for delivering materials and communication with students.

The student questionnaire with 40 items covered issues such as teaching methods and tools used by their lectures and assistants, available learning tools and aids as well as their satisfaction with efficiency and effectiveness of the teaching process.

This research aimed to identify the main factors of low passing rate on exams via teachers' and students' review of the teaching environment, methods and tools and gathering their suggestions for the improvement of overall math teaching and learning environment.

Target Group

Four mathematics teachers from the University of Split, Faculty of Maritime Studies were invited to participate in our survey. There were 3 responds from 2 female teachers and 1 male teacher, one with scientific-teaching position and two with a teaching position. Their professional experience as mathematics teachers ranged from 6 years to 15 years. All teacher participants completed a teacher education.

The second group included students from the University of Split, Faculty of Maritime Studies and Department of Naval Study of Split. They were asked to fill the online questionnaire, prepared on the Croatian language, anonymously and voluntary. 175 university students at the University of Split, Faculty of Maritime Studies (160) and Department of Naval Study of Split (15) participated in the study. The sample consisted of 114 males and 61 females with a mean age of 22.55. There were some differences between participating studies in numbers of participating men and women. 65% of all participants are male students. The highest representation of female students is in Maritime Management (34) and Maritime Yacht and Marina Technologies (11) studies. Three participants (1.7%) are foreign students. Participants are mostly first-year students (64 students).

Table 1.3. Sex of respondents

Students	**No**	**Students**	**No**
FULL_TIME	**135**	*PART_TIME*	*40*
Female	48	Female	13
Male	87	Male	27

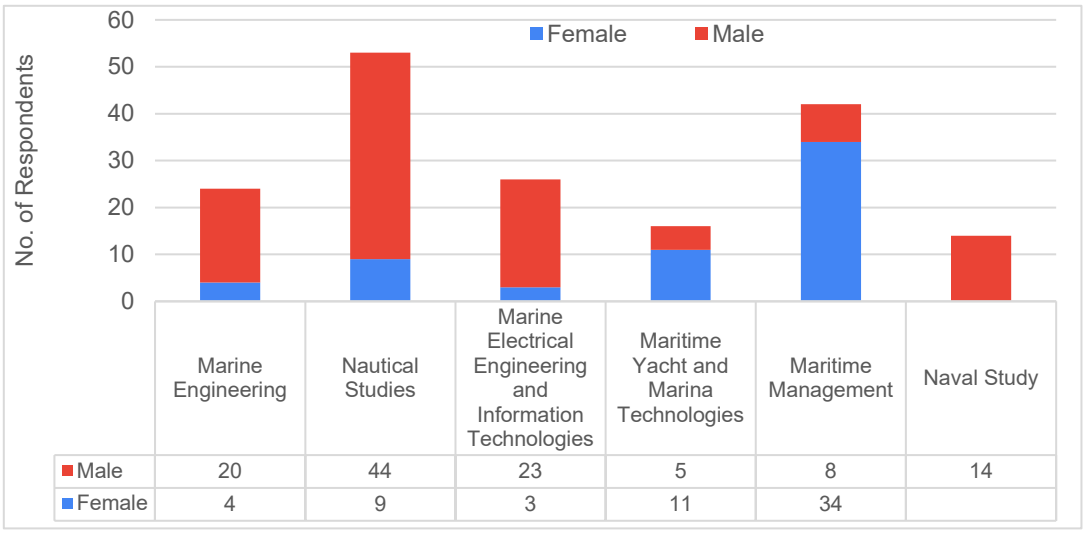


Figure 1.1. Sex of respondents by their study

Student background

The average age of all students was 21.8 years. The average age of the individual subgroups are: full time - 21.8 years, part-time - 25.6 years. The distribution of completed high school and respondents is stated in the table below:

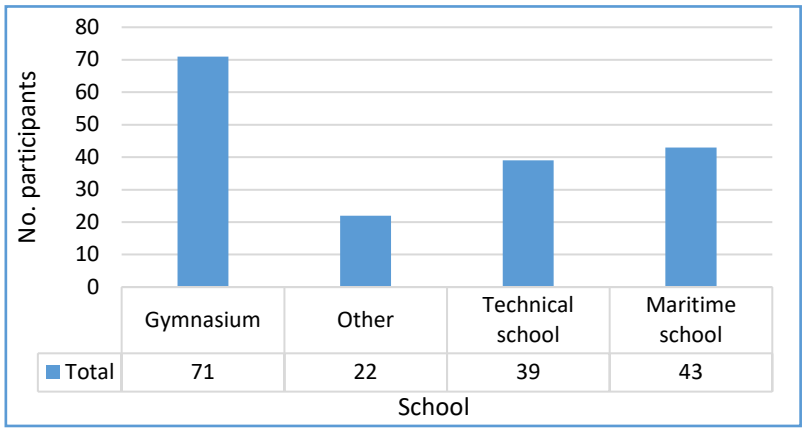


Figure 1.2 High school which students completed

The majority, more than half (63 %) of all full-time and part-time participated students, had a very good overall grade average in last year of high school. Approximately 19% of those respondents had excellent grade. The detail distribution of overall grade average in the last year of high school among student's status is stated in the table 4.

Table 1.4. Overall grade distribution

Overall grade average in the last year of high school:	*No. of respondents*	
	FULL_TIME	PART_TIME
2.0 - 2.99	4	2
3.0 - 3.49	13	12
3.50 - 4.49	90	20
4.50 - 5.0	28	6
Grand Total	135	40

170 respondents passed the final graduate exam in mathematics. Most of them (70/170 = 49%) achieved good success. Approximately, 29% of respondents had sufficient success, 25%

very good and only 6% excellent success. From the other side, the majority, 64 % (74/115) had had sufficient success in the last mathematical course that they passed during their higher school education. As many as 34.3% have not yet passed any mathematics subjects. The detail distribution of their grades is presented in the figure below.

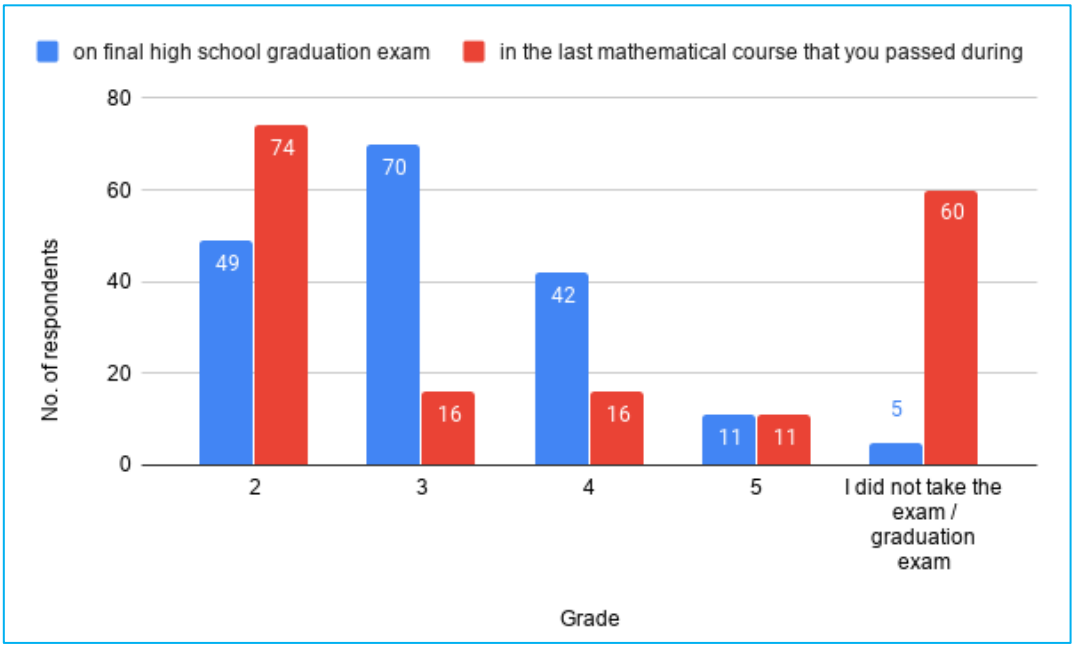


Figure 1.3. Student's grade from mathematics

Despite these results, the majority of all students (43.4%) rated their prior mathematical knowledge as good, 24% of them as very good, 20% sufficient, 7.43% excellent and 5.14% insufficient (Figure 4).

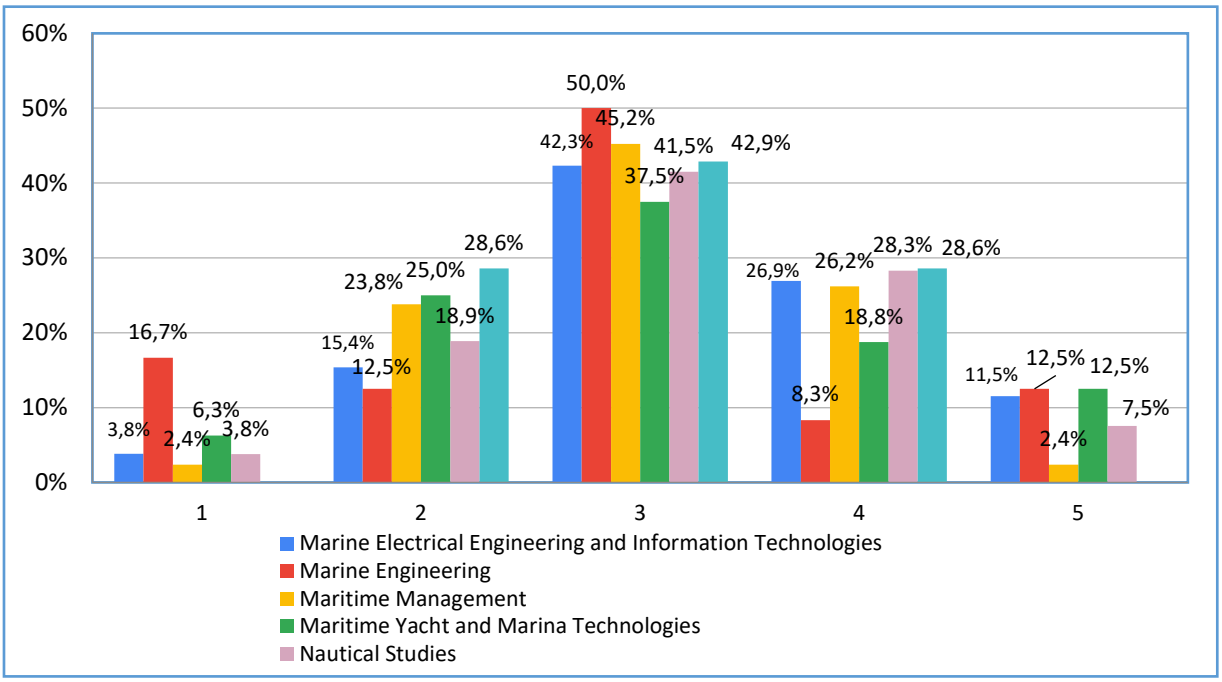


Figure 1.4. Students' rating of their previous mathematical knowledge

3. Report of teacher and student surveys – quality analysis

Tool review

SIGN, LITERATURE, EXAMS

Teachers were asked about the tools how they inform students about the goals, learning outcomes, grading criteria and evaluation methods of your about. The following table presents the results.

Orally in the introductory lecture	*In writing form*	*Orally in the introductory lecture and in writing form*	*As guideline outlined on the Faculty's website*
		2	1

From the other side, students were asked to indicate their agreement that the learning outcomes and assessment criteria are clearly defined (from 1- Strongly Disagree to 5 - Strongly Agree). Their average grade is 3.1 which means that they are neither satisfied nor unsatisfied with defined learning outcomes and assessment criteria.

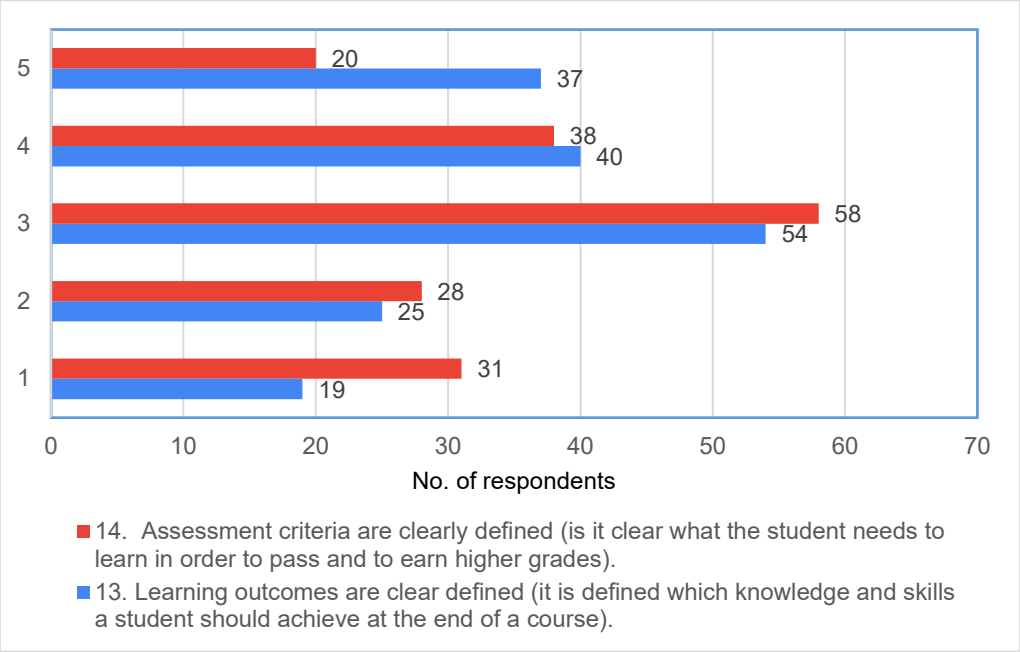


Figure 1.5.

All teachers recommend students teaching materials published on the Internet or e-learning system as literature.

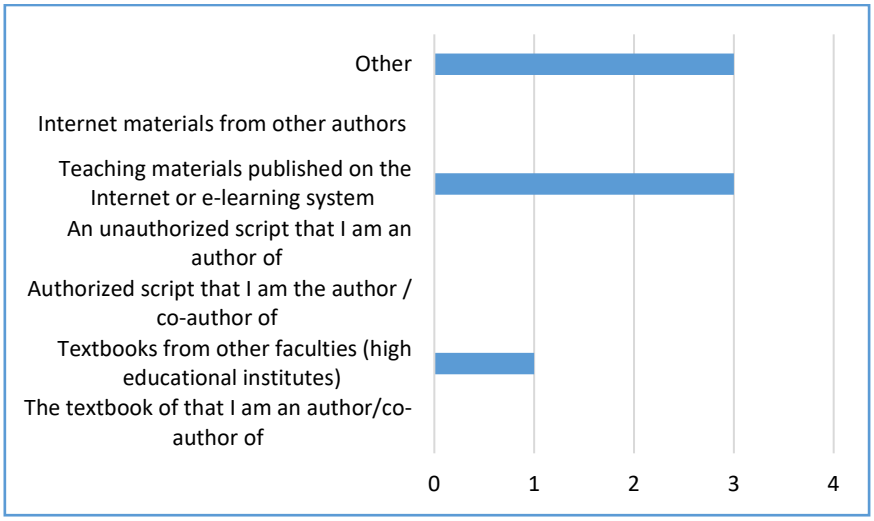


Figure 1.6.

Students were asked to expose their satisfaction with literature availability and appropriate literature. Mostly of students (66%) are not satisfied with the availability of literature and 64% of students strongly agree that literature is appropriate and useful for exam/midterm preparing. The average grade for literature availability is 3.09 and for literature appropriate is 3.74.

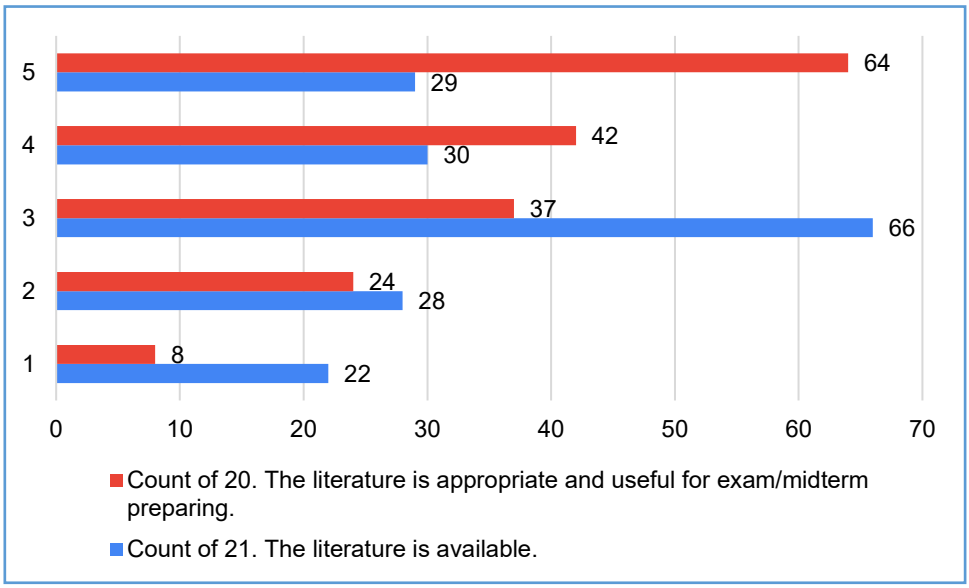


Figure 1.7. Distribution of students' rating on literature

TEACHING, LEARNING AND COMMUNICATION TOOLS

The first point which the survey tried to clarify was the general use of IT and whether it is used for teaching and communication with students. In that respect, the teachers were asked what type of IT they use in the communication process. As expected, Faculty's website and Merlin e-learning have dominated the scene, with 100% of the teachers using them for distribution added learning materials (presentations, student's tasks, past exams...) (Figure 8). It is useful because students always (46%) or often (37%) learn from past exams and always (42%) or often (25%) learn from lecture notes on topics (Figure 9). However, it is not enough because 45% of students always or often use additional on-line learning materials. Additionally, 49% of students always or often ask a fellow student for help in learning and 41% of them always or often attend individual instructions outside of the Faculty. The very low percentage of students (22%) ask the teachers for help in learning. No one teacher doesn't use social networks for communication with students and, probably, it is the main reason why very high per cent of students never use them for learning. That is despite the fact the free WIFI is available, from one side, and students are very familiar with social media, from another side.

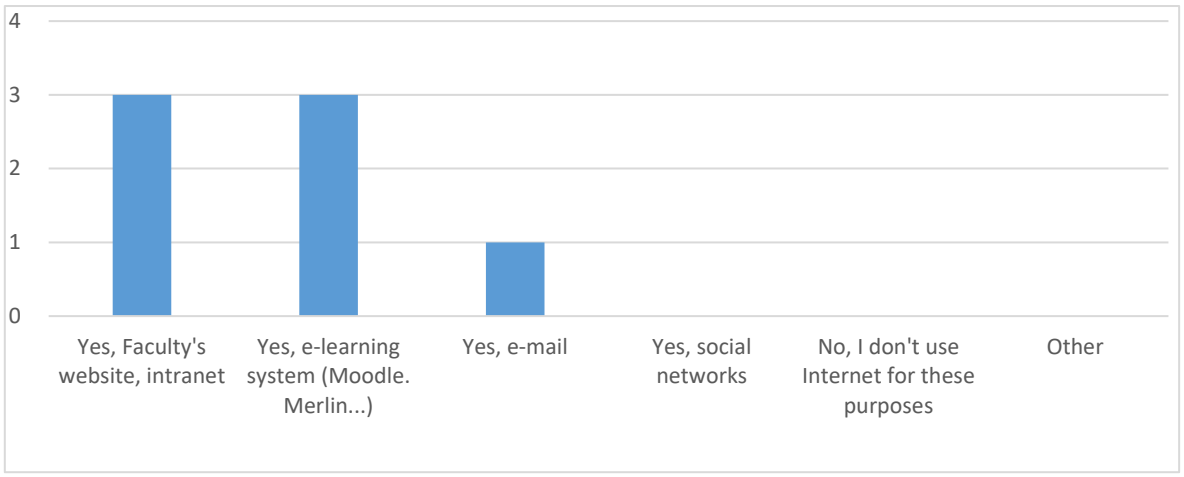


Figure 1.8. Tools for distribution added learning materials and communication with students

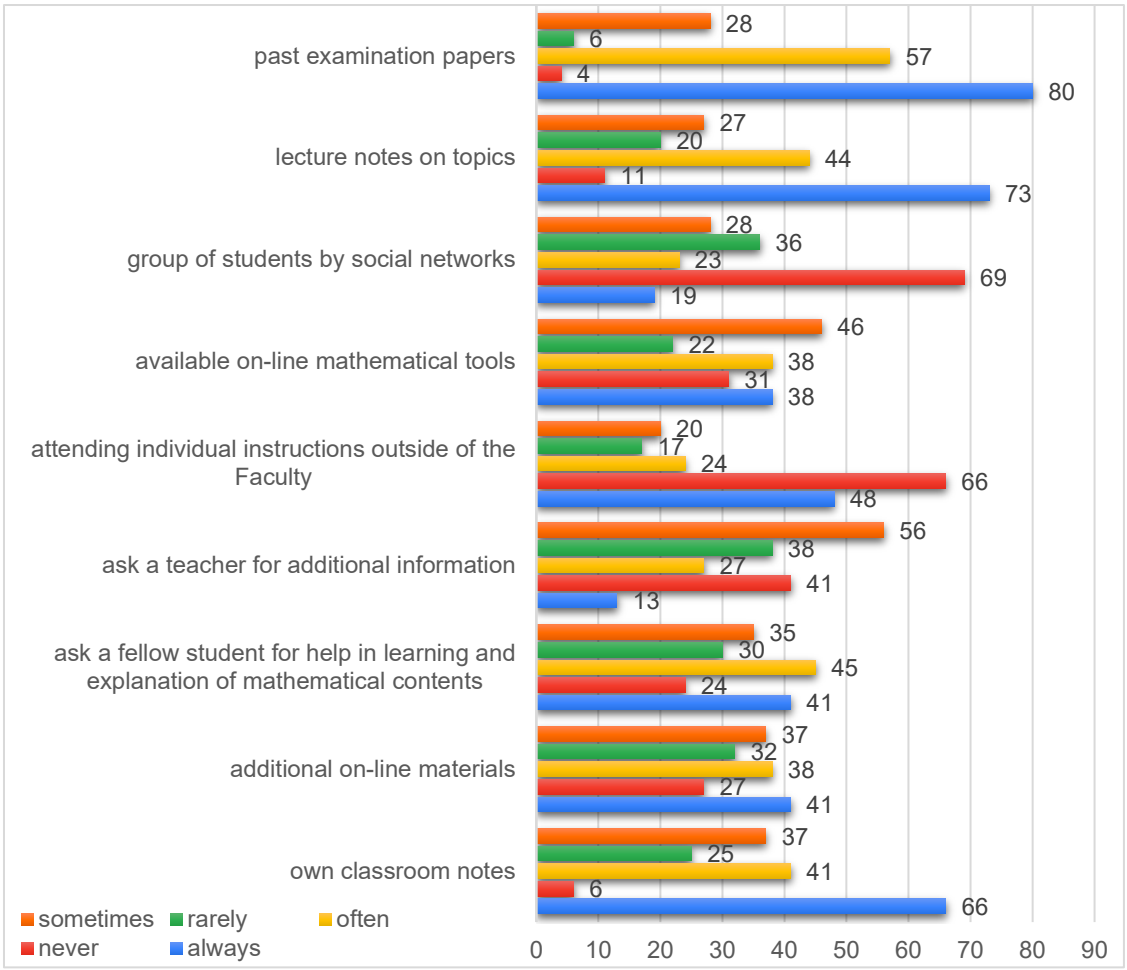


Figure 1.9.

Also, students were asked what type of IT their teachers use for teaching. As expected, blackboard and marker pen is dominated (Figure 10). There was also a very high percentage for PowerPoint presentations. There was a relatively low use of video clips and animations and quizzes or on-line tests. Figure 11 confirms that majority of teachers use presentations as visual aid in teaching process.

A majority of students (51%) confirmed that they are not satisfied with resources and learning support from the teachers while 49% of students are satisfied with either availability of the teachers for helping them (by emails or on the consolations). However, in the above aspects there were also a lot of neutral answers (73%).

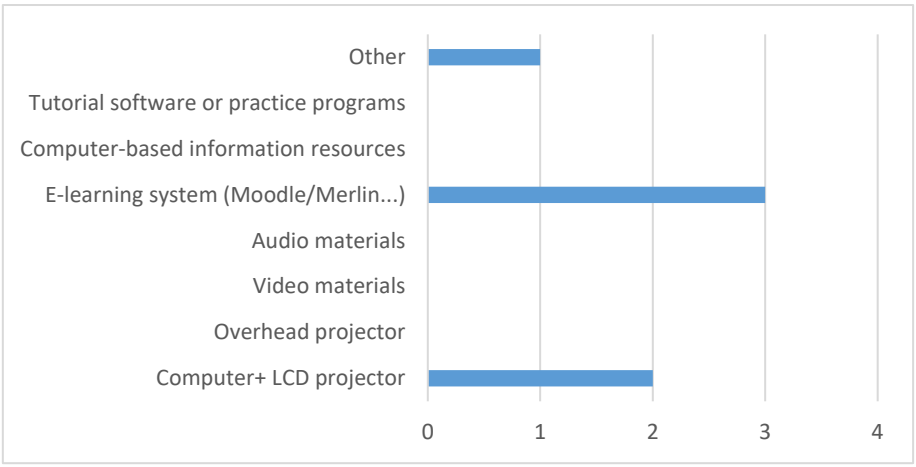


Figure 1.10

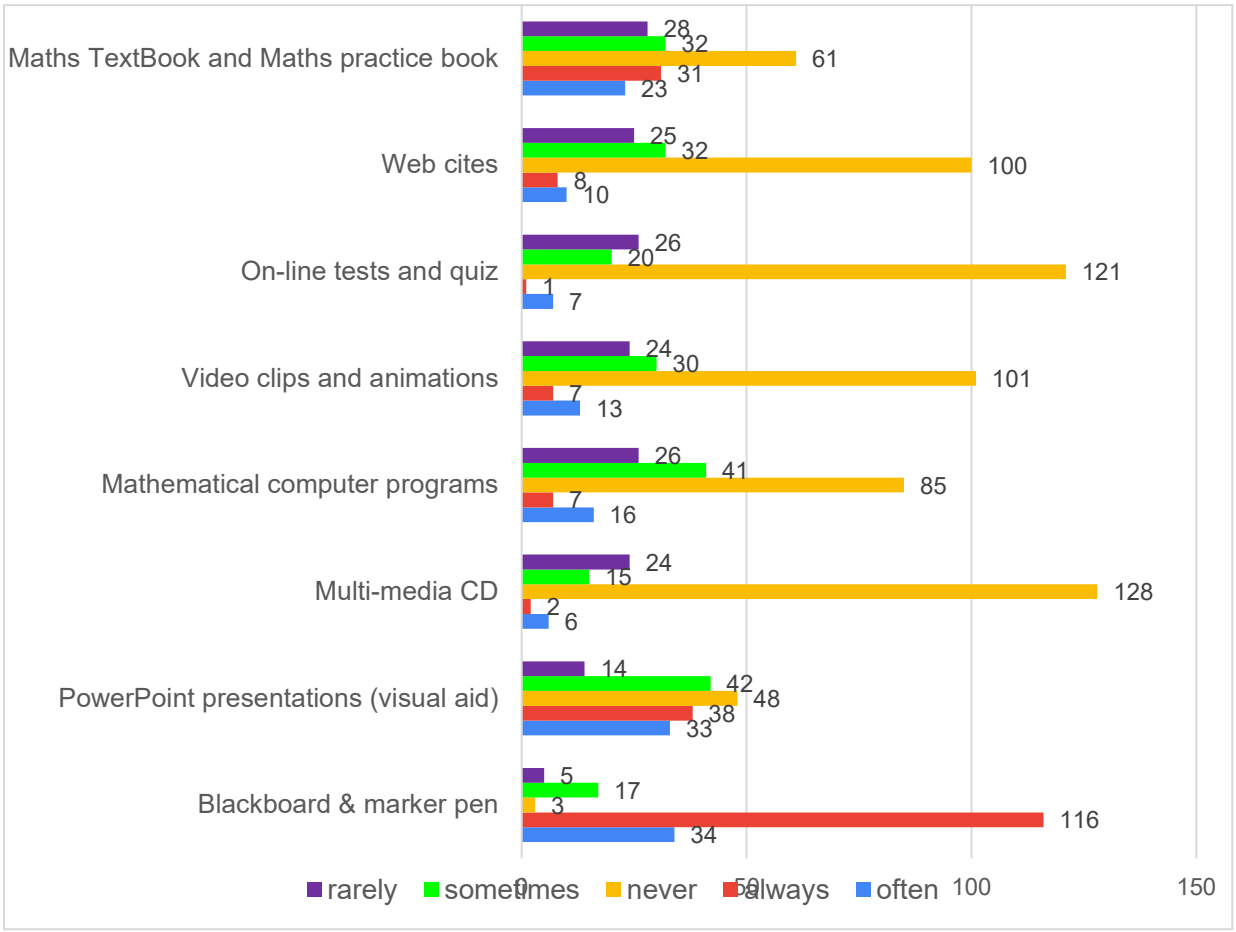


Figure 1.11

Teachers' responses on the item "An exam of your course is organised as" are as follows:

Exclusively as written	Exclusively as oral	Written and oral	Written or oral	Other
	0	3	0	0

Sum up

Teachers	Communication with students is mainly by emails. The course syllabus, teaching plan, assessment plan and teaching materials delivery to the students mainly published them on website. For teaching and lesson presentation they prefer to use blackboard and marker pen together with PowerPoint presentations. There are very low use of some modern resources such as interactive quizzes or on-line tests, video clips and animations.
Students	Mainly, students have used posted materials on topics and past exams for learning which are incomprehensible and extensive to many students. Certainly, they have used help from other online materials. Many of students have looked for the help from other students or taking private instructions outside of the Faculty. They have sometimes exchanged ideas and opinions between themselves using social networks but they certainly preferred to face to face or mailing communicate with the teacher. There was a relatively low use of public computer math applications.

Need analysis

Table 5 presents the distribution of responses and descriptive statistics across items that show teacher satisfaction with the teaching environment. There are five related items and five response options have been used on each item. Of each item, the choices were heavier from *Strongly Disagree* to *Strongly Agree*. Each item indicated a mean greater than 3 (on a scale of 1 to 5) and average *SD for all items is* about 0.8.

Table 1.3 Distribution of Responses and Descriptive Statistics across Items

	1 - strongly disagree	2 – disagree	3 - neutral	4 – agree	5 - strongly agree		
10. The space and technical conditions for teaching are appropriate to the teaching needs.	0			1	2	4.67	0.58
11. The availability of teaching aids meets the needs of the course.	0			1	2	4.67	0.58
12. Collaboration with other math teachers is successful.	0		2	0	1	3.67	1.16
13. The number of students is well aligned with the available teaching capacity.	0		1	2	0	3.67	1.16
14. You have enough time to prepare myself for teaching	0		0	1	2	4.67	0.58

From the other side, students mostly confirmed that attending lectures or exercises has contributed to an increasing their knowledge and made easier to prepare them for exams/midterms (Figure 12).

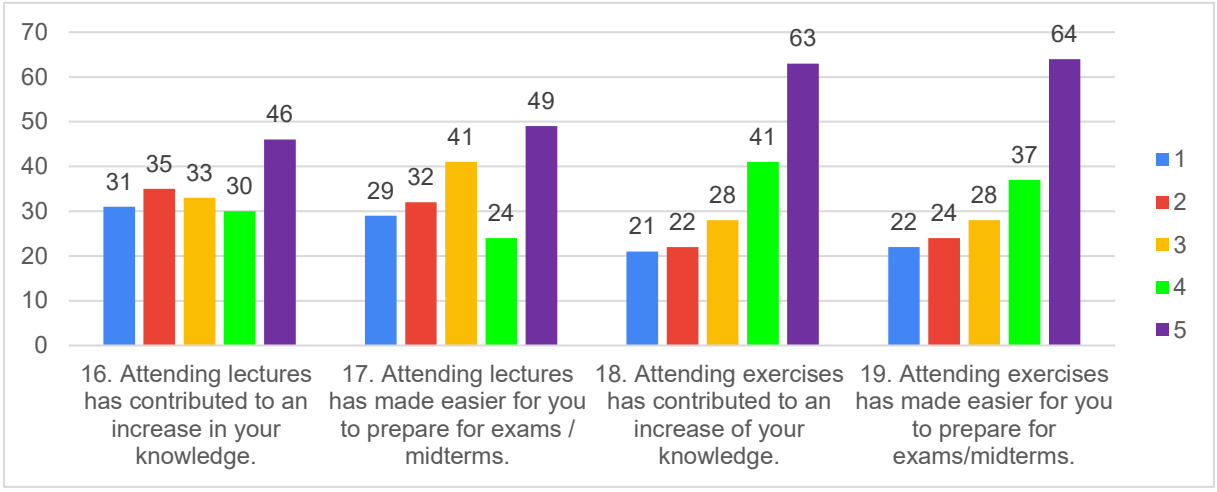


Figure 1.12. Student' responses regarding the effectiveness of attending classes

CLASSROOM EXPERIENCES

From the teacher's responses, from one hand, they try to explain matter students as better as possible (Figure 13). From the other hand, they mostly use traditional teaching methods, don't use interactive contents and rarely connect solving math tasks with real problems (Figure 15). It is clear that is the main reason why students have considered teaching methods as uninteresting and unsuitable (Figure 17).

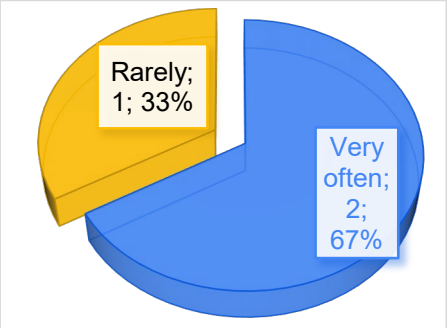


Figure 1.13. Distribution of teacher' responses on the item "During your class do you explain a matter again if it is not clear to them?"

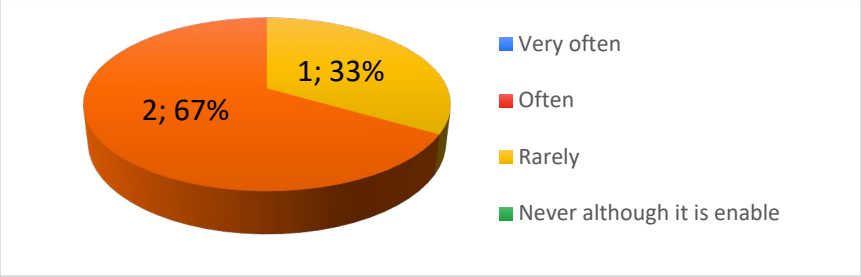


Figure 1.14. Techer' responses on the item" Students work in small groups to come up with a joint solution to a math problem."

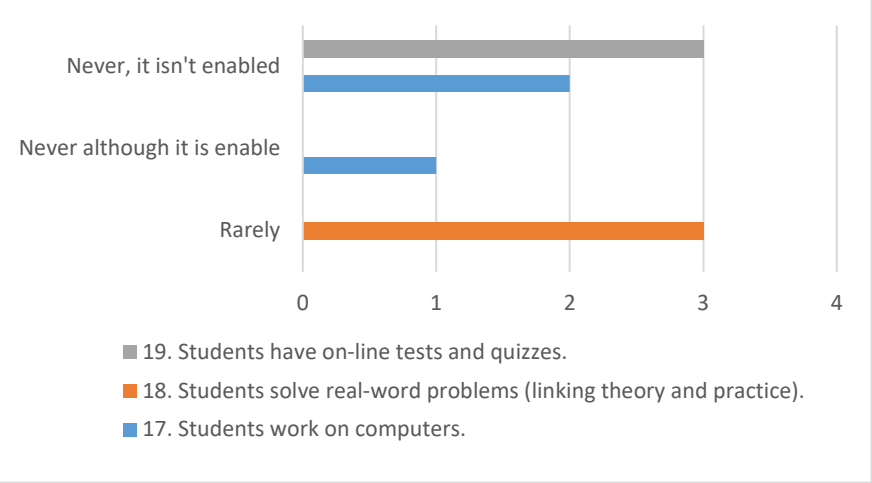


Figure 1.15. Teacher perception of student participation in learning activities

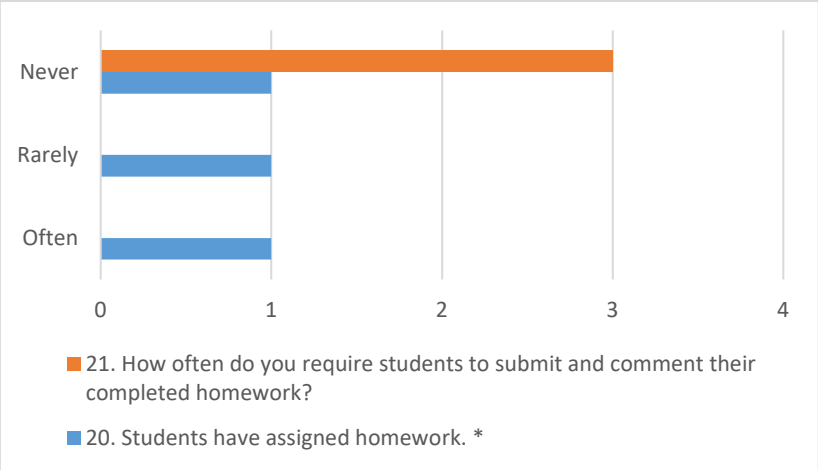


Figure 1.16. Homework activities

Figure 17 represents that students' opinions on the way of teaching, their suitability and attractiveness, are divided. Only, 22% of students are satisfied and 11% are very satisfied with the teaching methods. As many as 31% of students rated the methods as absolutely inappropriate and uninteresting.

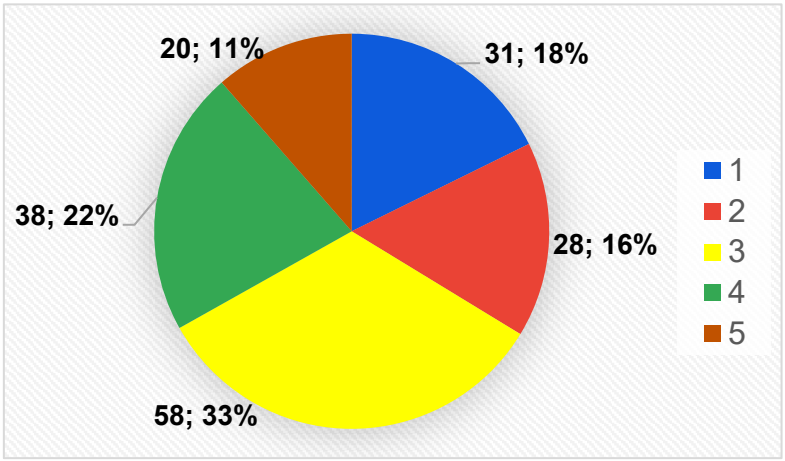


Figure 1.17. Students' rate on suitability and attractiveness of teaching methods

Teachers' assessment of student's performance and behaviour

From the teachers' perspectives (Figure 18), results revealed a very low level of students' prior knowledge, their interest in the math courses and they rarely prepare for tracking classes. The reasonable explanation can be found in students'' perception of teaching maths (Figure 20). The students have not realised the importance of mathematics in their profession and in solving real problems, what the teachers rarely try to show.

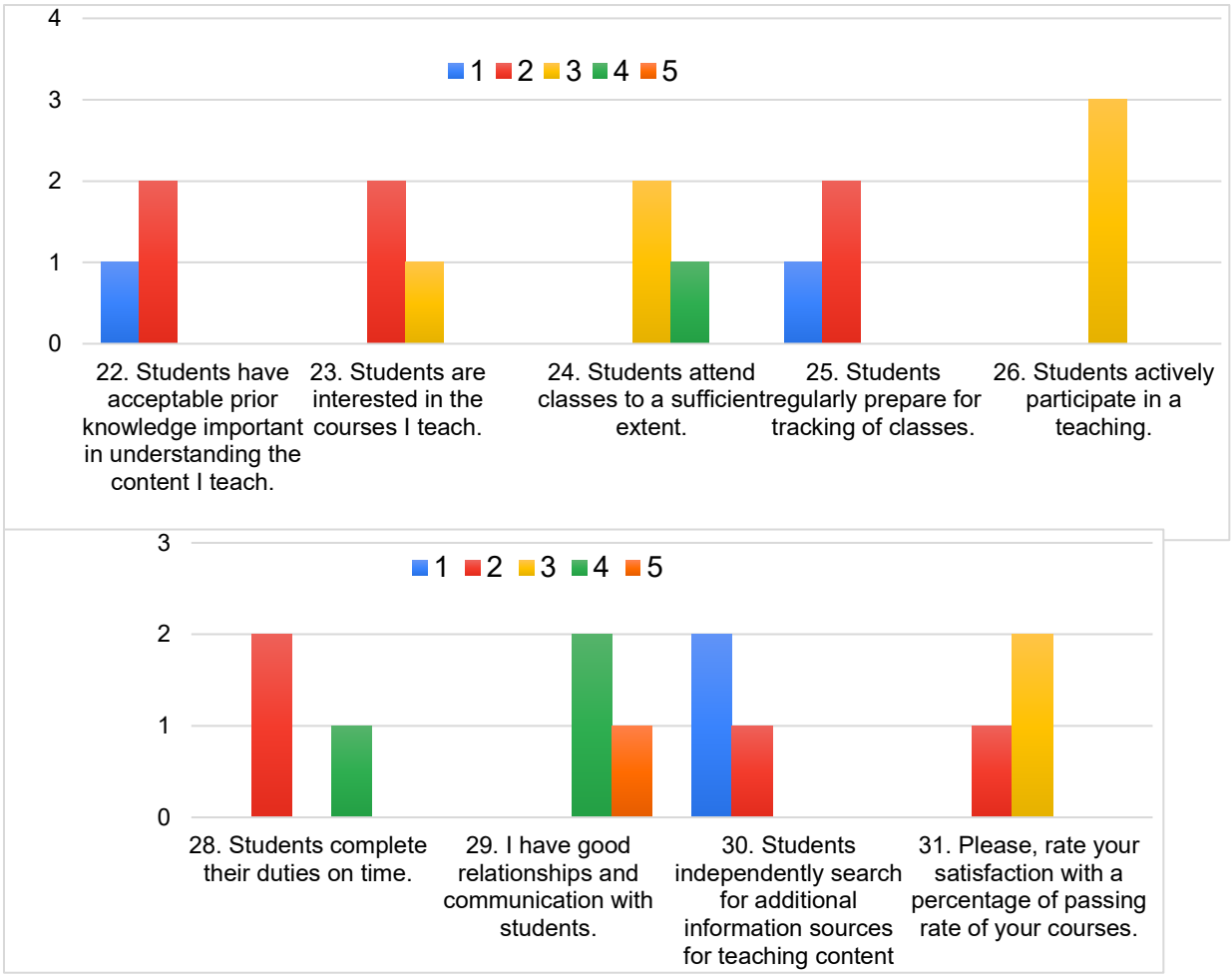


Figure 1.18. Overall teacher' satisfaction with student's engagement

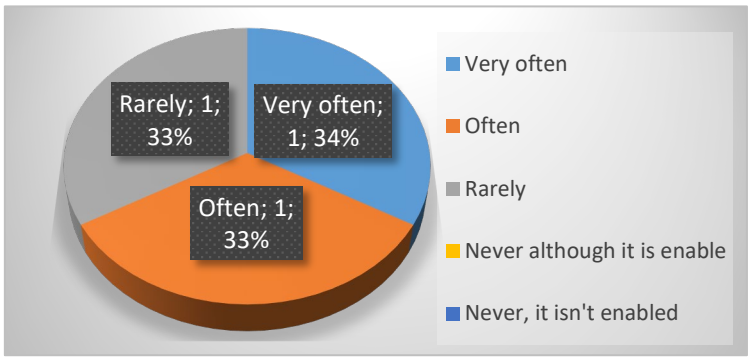


Figure 1.19 Teachers confirmed that students often ask them to explain a matter if it is not clear something

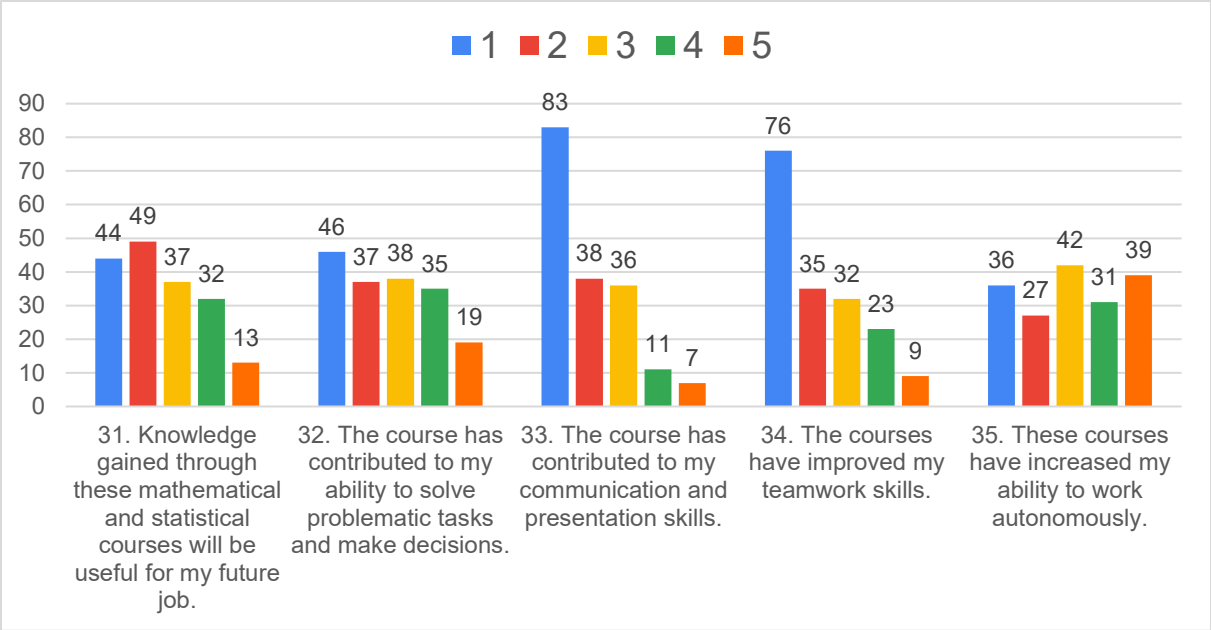


Figure 1.20. Students' perception of math importance for their future job and for improving their skills

From Figure 18 it is obvious that the teachers are not satisfied with the success level of passing exams. According to their opinion, what is the main reason for the achieved percentage passing rate are: *lack of student engagement, not sufficient basic knowledge the students have gained in high school, students are not motivated, students consider that they maths course are useful little.*

To raise the percentage of passing rate of math courses they recommended following: better *prior knowledge gained in high school, the formation of smaller groups of students for lectures and exercises, more teaching hours for exercises, setting constraints in relation to other subjects, explain again some matter from high school.*

Students' assessment of teacher's performance

From Figure 21 to Figure 23 it can be concluded that the main students recognized the organizational and teaching skills of their lecturers and assistants.

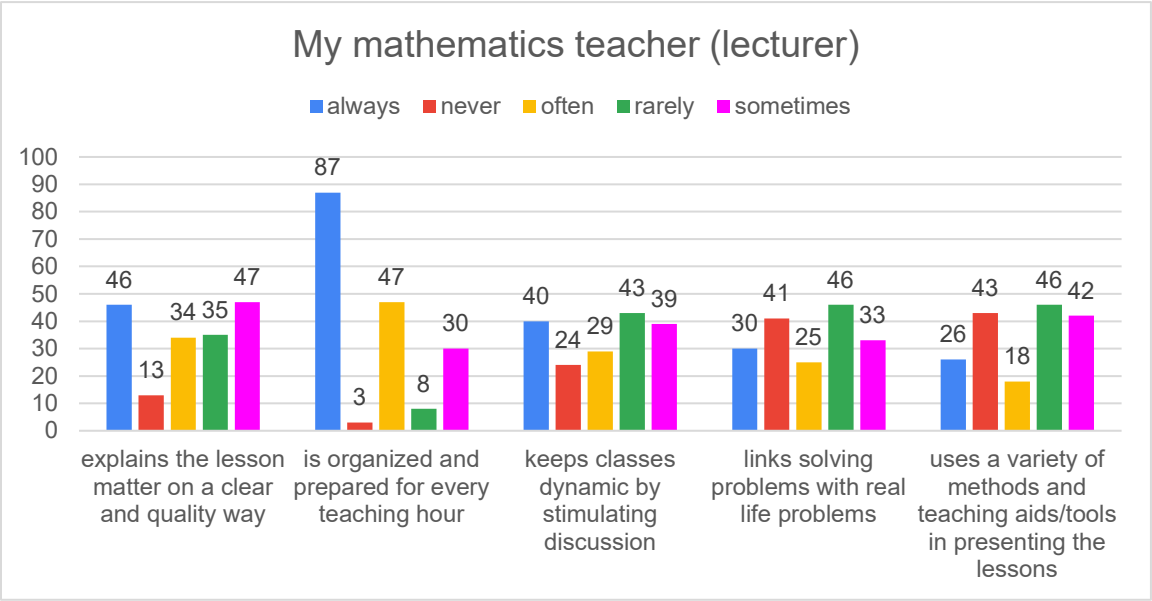


Figure 1.21

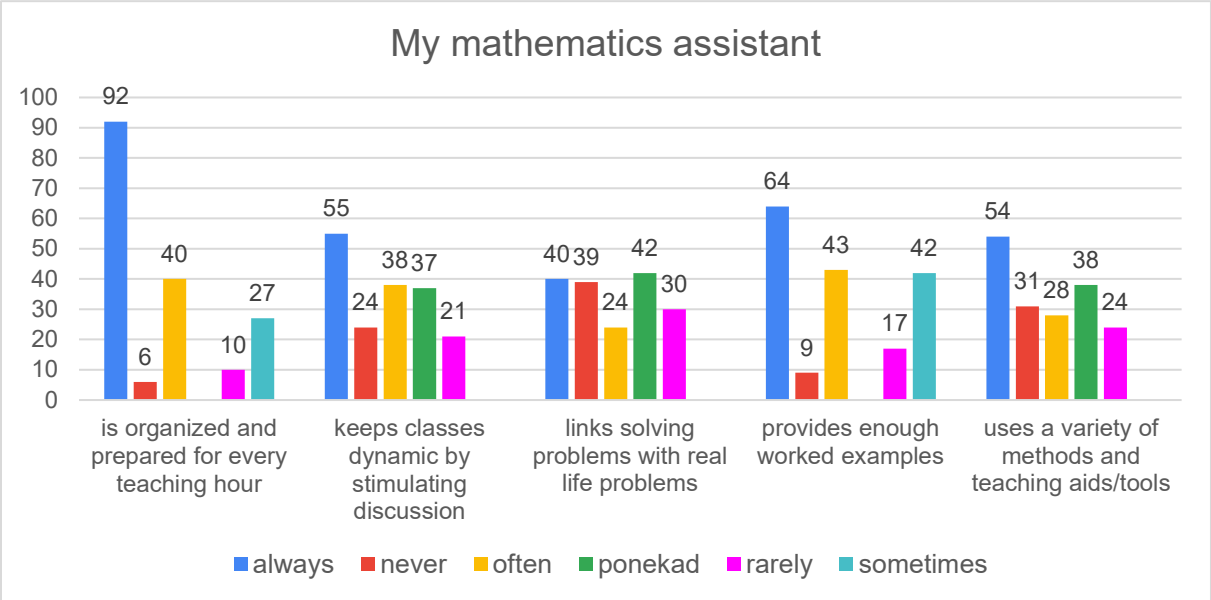


Figure 1.22

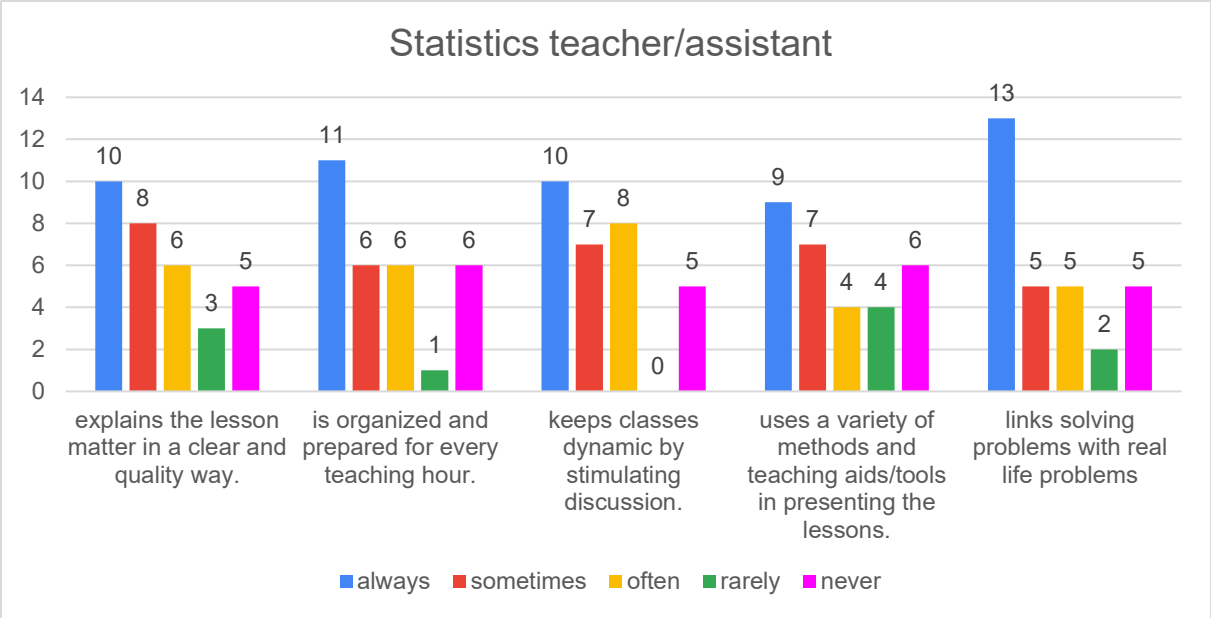


Figure 1.23

Sum up

Figure 24 shows that teachers considered the performance of their teaching in the prior academic year as very successful.

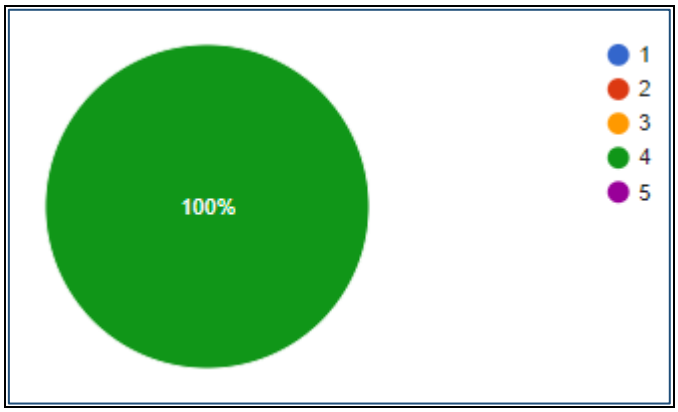


Figure 1.24 Teachers' grade of performance of their teaching in the previous academic year 2018./2019.

Students haven't shared teacher's opinion. They graded math courses as shown on Figure 25.

They average graded the courses is as follows:

Mathematics 1: 2.94 Mathematics 2: 2.98 Applied Mathematics in Navigation; 2.41
Statistics: 2.25

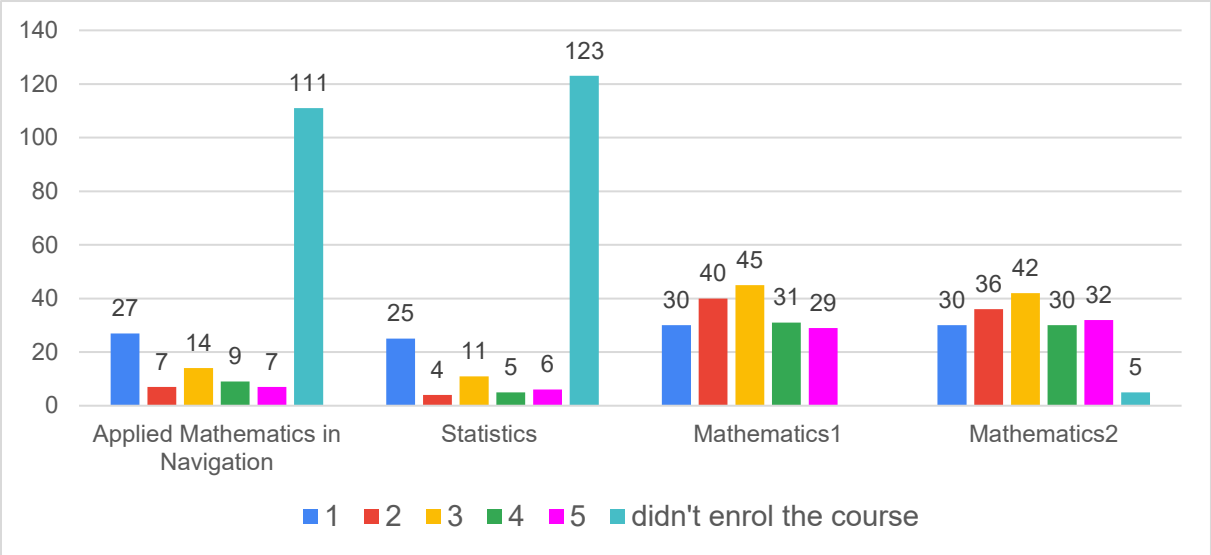


Figure 1.25 Students' grade of their satisfaction with Maths

4. Conclusion

From the presented results, it is evident that there are shortcomings and dissatisfaction in the teaching and learning of mathematical subjects,

On the one hand, teachers mostly use traditional methods and tools. They are unsatisfied with students' prior knowledge, their interest and motivation, and passing exams.

On the other hand, students appreciate the effort of teachers, but do not see the importance of mathematics for their future profession. It is important to seriously consider their comments such as: *too much material and too little exercise, they have poor prior knowledge, professors need to give easier assignments, lectures should be better and lack of material for the oral part of the exam, the students should participate in teaching, the coordination of professor and assistant is very bad, difficulty of tasks, plenty of ambiguity in lectures, math is unnecessary, the teacher just goes with new content*...

In conclusion, there is a need to do the teaching and learning process better that include classroom activities which:

- Have a high level of student engagement
- Including a combination of cooperative learning, dynamic matters, hands-on investigations, and manipulatives
- Connect to students' knowledge with solving problems from real-world applications
- Show students why mathematics is important for their future jobs.

In that sense, teachers should transform their teaching from traditional methods and tools to the application of modern IT and solving math tasks by joining with real problems. However, with the many advances in technology, it is much easier to make math lessons fun. In addition, technology can also make the math teacher's job a lot easier by providing pre-made activities, options for differentiating and even helping with pre- and post- assessments (including grading!).

Estonian Maritime Academy

Abstract

The report represents results of the survey carried out in summer 2020 between students of the Estonian Maritime Academy of Tallinn University of Technology. Due to the vacation time the number of respondents participated in survey is not high: 49. The aim of the survey is to review the overall situation with mathematical courses and eliminate the main shortcoming in methods, resources and tools used for teaching. The rate of students' success on mathematical exams, dropout rate and the suggestions to eliminate reasons of the variations discussed.

The report is divided into 3 parts. In the first part the overall background of the respondents is described: gender, basic maths knowledge level, high school distribution, etc. The second parts is focused on the description of the structure of the questionnaire and main results of the survey. Third part discusses the result of the open questions on comments and suggestions for improvement of the teaching process.

Need for the Study

Courses based on mathematics are represented in different variations in all study programmes of the Estonian Maritime Academy at Tallinn University of Technology. These courses include both lectures and exercises. The course Higher Mathematics I represented almost in every study programme (except Business and experience management). Course Higher Mathematics II presents advanced mathematics and represented in the following study programmes: Waterway Safety Management, Ship Engineering, and Navigation. Beside of the general mathematical courses, there are also speciality specific courses such as Higher Mathematics and Operations Research, Mathematical Methods of Data Analysis, Business Mathematics, and Engineering Mathematics. These courses developing advanced skills in mathematics and focus on specific topics related to the speciality (see Table 1 for details).

Table 1 presents the results of student success of passing final exams for eight courses of the period 2018-2019. During the last academic year, the percentage of students that successfully passed mathematical courses varies drastically. While the overall percentage of passed exams in Higher Mathematics I is moderate and varies between 49% (Port and Shipping Management) and 62% (Waterway Safety Management), the rate of excess in passing the exam in the first try is varies much for different study programmes (see Table 1).

If Waterway Safety Management study programme students pass their maths exam 100% from the first try, students from other study programmes were managed to pass the exam only from the second try. There is also high rate of students, who did not managed to study mathematics and dropped out form the studies. According to the numbers in Table 2, the dropout rate exceeds 30% and non-pass rate exceeds 50% for some study programmes (Port and Shipping Management). This trend is evident only for the course Higher Mathematics I and does not present for other speciality specific math courses. Only speciality specific course Business Mathematics shows even higher non-pass rate – 69%.

This course is only math course represented in the study programme Business and experience management.

The situation described above gives an evident signal that the teaching methods are not effective enough to fully engage students to study mathematics and further developments are needed to improve this situation.

Table 2.1. Number and percentage of students who passed the final exam in the mathematical courses at TalTech Estonian Maritime Academy

Year: 2018/2019	Higher Mathematics I			Higher Mathematics II (6EAP)			Higher Mathematics II (3EAP)			Higher Mathematics and Operations Research			Mathematical Methods of Data Analysis			Loogics			Business Mathematics			Engineering Mathematics		
Undergraduate studies	Enrolled students	Pass (C)	Pass (%)	Enrolled students	Pass (C)	Pass (%)	Enrolled students	Pass (C)	Pass (%)	Enrolled students	Pass (C)	Pass (%)	Enrolled students	Pass (C)	Pass (%)	Enrolled students	Pass (C)	Pass (%)	Enrolled students	Pass (C)	Pass (%)	Enrolled students	Pass (C)	Pass (%)
Waterway Safety Managment (KV)	**21**	**13**	**62%**	**12**	**7**	**58%**							**9**	**8**	**89%**	**9**	**6**	**67%**						
re-enrolled				2	1	50%										0	0							
first time	21	13	62%	10	6	60%							9	8	89%	9	6	67%						
Ship Engineering (LM)	**30**	**18**	**60%**				**20**	**11**	**55%**															
re-enrolled	5	4	80%																					
first time	25	14	56%				20	11	55%															
Port and Shipping Managment (KS)	**49**	**24**	**49%**							**50**	**22**	**44%**				**38**	**33**	**87%**						
re-enrolled	3	1	33%							20	10	50%				0		50%						
first time	46	21	46%							30	12	40%				38	33	40%						
Navigation (LL)	**51**	**30**	**59%**				**36**	**32**	**89%**															
re-enrolled	2	0	0%																					
first time	49	30	61%				36	32	89%															
Business and experience management																			**28**	**25**	**89%**			
re-enrolled																			2	0	0%			
first time																			26	25	96%			
Marine Engineering	**28**	**16**	**57%**																			**18**	**12**	**67%**
re-enrolled	6	5	83%																			2	1	50%
first time	22	11	50%																			16	11	69%
Grand Total	**151**	**85**	**56%**	**12**	**7**	**56%**	**56**	**43**	**56%**	**80**	**25**	**31%**	**9**	**8**	**89%**	**9**	**6**	**67%**	**28**	**25**	**89%**	**18**	**12**	**67%**

Table 2.2. Number and percentage of students who dropped from the study and failed the mathematical courses. Dropout (%)* - the percentage of dropped students from enrolled on the course; Non Pass (%) - dropout rate of students enrolled the course / number of students dropped from the study.

Year: 2018/2019		Higher Mathematics I (matan)					Higher Mathematics II (6EAP)				
Undergraduate studies	Dropout rate from the study	Enrolled students	Dropout (C)	Dropout (%)*	Non Pass (C)	Non Pass (%)	Enrolled students	Dropout (C)	Dropout (%)*	Non Pass (C)	Non Pass (%)
Waterway Safety Managment (KV)	11	21	5	24%	3	45%	18	2	11%	5	18%
re-enrolled	7						2		0%	1	
first time	5	21	5	24%	3		16	2	13%	4	
Ship Engineering (LM)	26	30	5	17%	9	19%					
re-enrolled	18	5		0%	1						
first time	8	25	5	20%	8						
Port and Shipping Managment (KS)	29	49	16	33%	27	55%					
re-enrolled	11	3		0%	2						
first time	18	46	16	35%	25						
Navigation (LL)	33	51	13	25%	21	39%					
re-enrolled	19	2		0%	2						
first time	14	49	13	27%	19						
Business and experience management	13										
re-enrolled	4										
first time	9										
Marine Engineering	16	28	6	21%	12	38%					
re-enrolled	9	6		0%	1						
first time	7	22	6	27%	11						
Grand Total	128	179	45	25%	72	35%	18	2		5	2%

Year: 2018/2019	Higher Mathematics II					Higher Mathematics					Mathematical Methods				
Undergraduate studies	Enrolled students	Dropout (C)	Dropout (%)*	Non Pass (C)	Non Pass (%)	Enrolled students	Dropout (C)	Dropout (%)*	Non Pass (C)	Non Pass (%)	Enrolled students	Dropout (C)	Dropout (%)*	Non Pass (C)	Non Pass (%)
Waterway Safety Managment (KV)											9	0	0%	1	0%
re-enrolled															
first time											9	0		1	
Ship Engineering (LM)	20	3	15%	9	12%										
re-enrolled															
first time	20	3	15%	9											
Port and Shipping Managment (KS)						50	2	4%	28	7%					
re-enrolled						20		0%	10						
first time						30	2	7%	18						
Navigation (LL)	36	1	3%	4	3%										
re-enrolled															
first time	36	1	3%	4											
Business and experience management															
re-enrolled															
first time															
Marine Engineering															
re-enrolled															
first time															
Grand Total	56	4		13	3%	80	3			2%					0%

Year: 2018/2019	Loogics (2year)					Business Mathematics					Engineering Mathematics				
Undergraduate studies	Enrolled students	Dropout (C)	Dropout (%)*	Non Pass (C)	Non Pass (%)	Enrolled students	Dropout (C)	Dropout (%)*	Non Pass (C)	Non Pass (%)	Enrolled students	Dropout (C)	Dropout (%)*	Non Pass (C)	Non Pass (%)
Waterway Safety Managment (KV)	9	0	0%	3	0%										
re-enrolled	0			0											
first time	9			3											
Ship Engineering (LM)															
re-enrolled															
first time															
Port and Shipping Managment (KS)	38	0		5	0%										
re-enrolled	0			0											
first time	38			5											
Navigation (LL)															
re-enrolled															
first time															
Business and experience management						28	9	32%	3	69%					
re-enrolled						2		0%	2						
first time						26	9	35%	1						
Marine Engineering											18	1	6%	6	6%
re-enrolled											2		0%	1	0%
first time											16	1	6%	5	14%
Grand Total					0%		9%			0%		1%			0%

Students' background

The survey of 49 students across all study programmes of Estonian Maritime Academy at Tallinn University of Technology of undergraduate level asked questions on the mathematical courses: their level of basic math knowledge, average grade from the high school and their attitudes toward the mathematical courses. This section provides an overview and summary of key analytical points of the target group.

More than half of the total number of students participated in the survey were male (33 students. Figure 1).

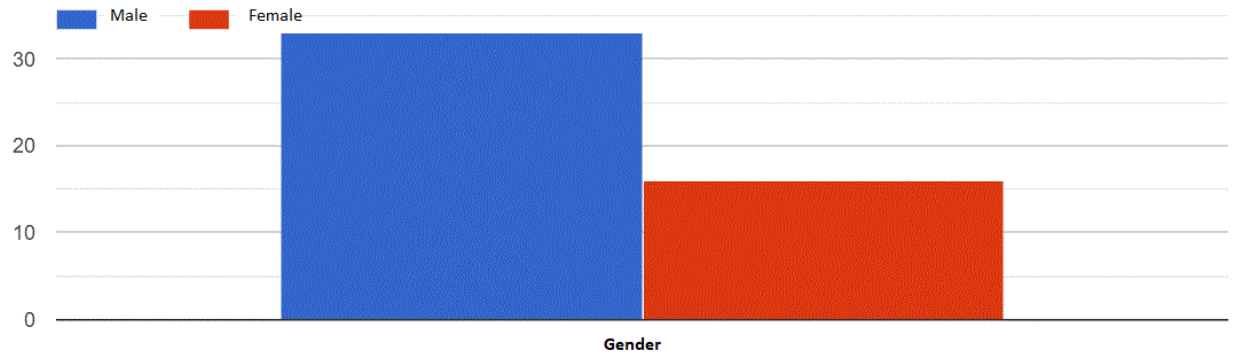


Figure 2.1. Respondents' gender distribution

The average age of the students is 23 years. More than 40% of respondents are 21-year-old students (Figure 2).

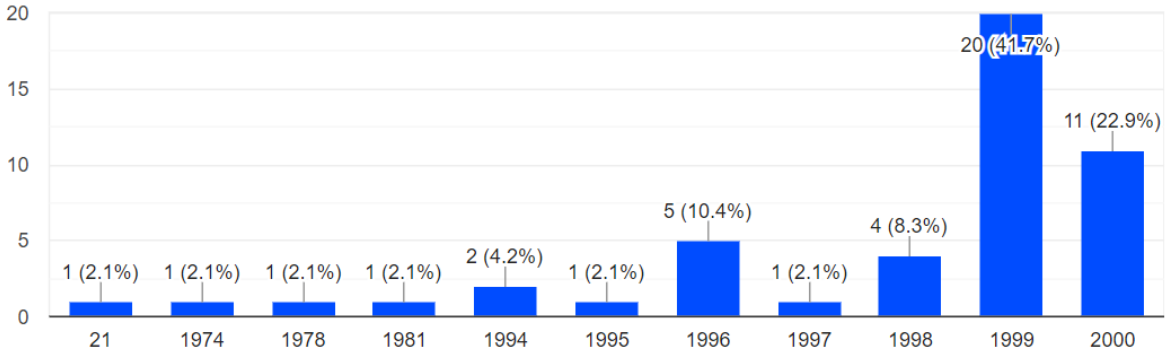


Figure 2.2. Age of the students

Most of the students participated in the survey study first or second year (32,7% and 36,7% respectively, Figure 3).

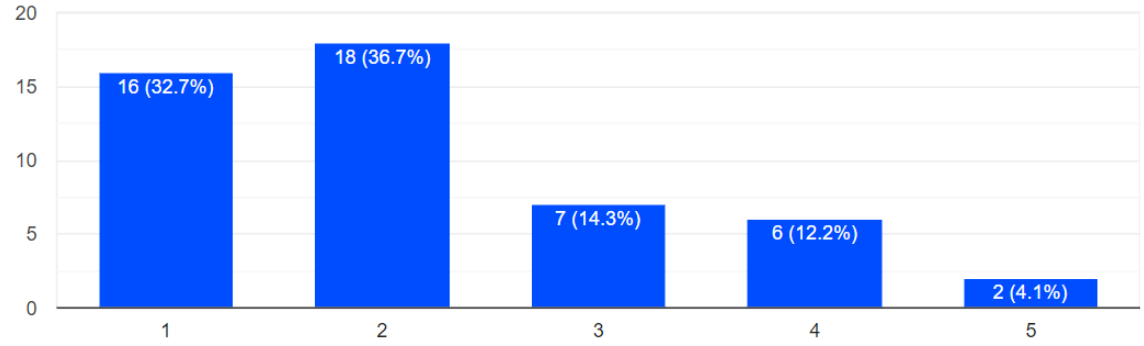


Figure 2.3. Students' distribution between study years. Horizontal axis represents the year of studies

All students are on full time studies (Figure 4).

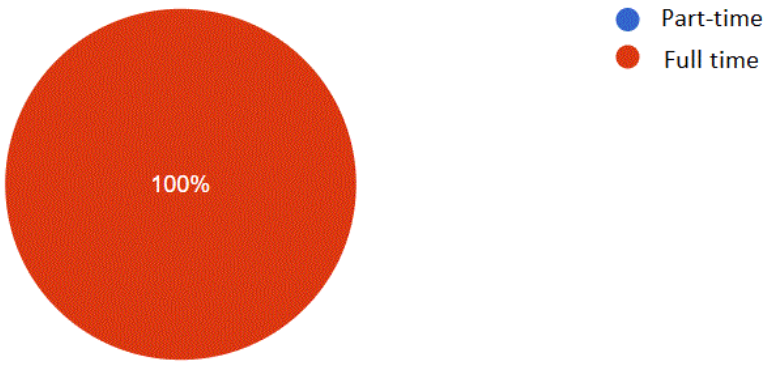


Figure 2.4. Study load

All study programmes of the Estonian Maritime Academy are represented in the survey analytics. There are five undergraduate study programmes in the university: Waterway Safety Management, Port and Shipping Managements, Navigation, Ship Engineering, and Marine Engineering. The programme Ship Refrigeration Engineering is closed, but since some of the students enrolled on this programme still completing their studies, they also participated in the survey. The students of this programme constitute 2% of the total number of respondents (1 student).

Despite of the fact, that the number of students enrolled on Waterway Safety Management programme is smallest, the students are the most active respondents, they constitute 34,7% (Figure 5).

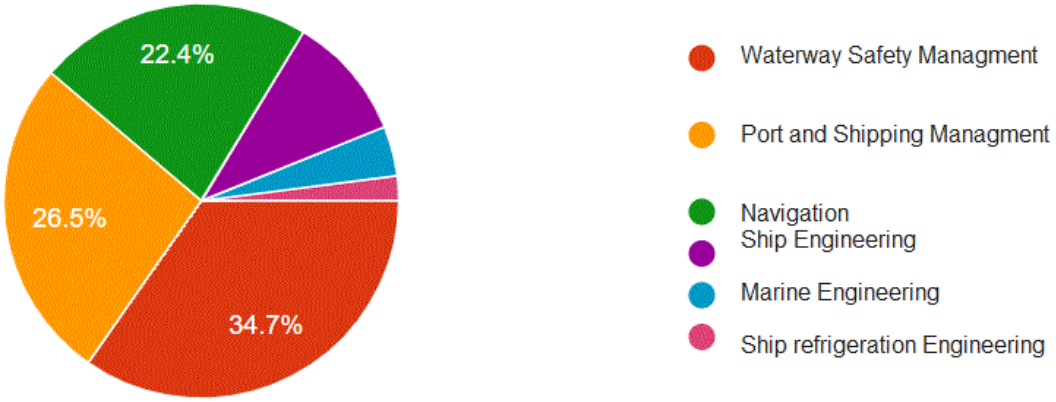


Figure 2.5. Distribution of the respondents by the study programme

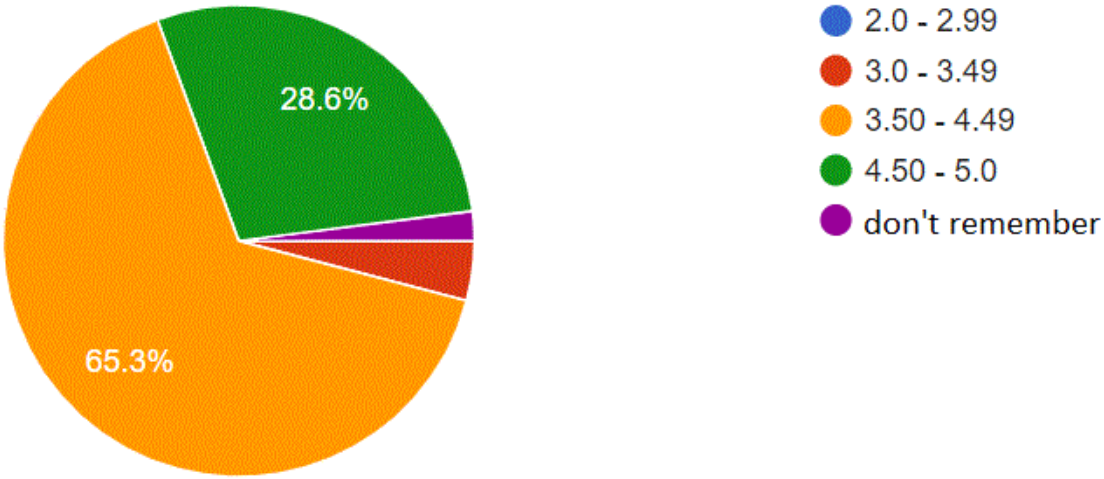


Figure 2.6. Distribution of the cumulative grade points average (CGPA) of the secondary school diploma

As for all undergraduate study programmes in Estonian Maritime Academy one of the admission criteria is cumulative grade points average, witch for the most study programmes should be over 3,5; there is only one student has grade lower than 3,5. 28,6% of the respondents' CGPA is over 4,5 (Figure 6).

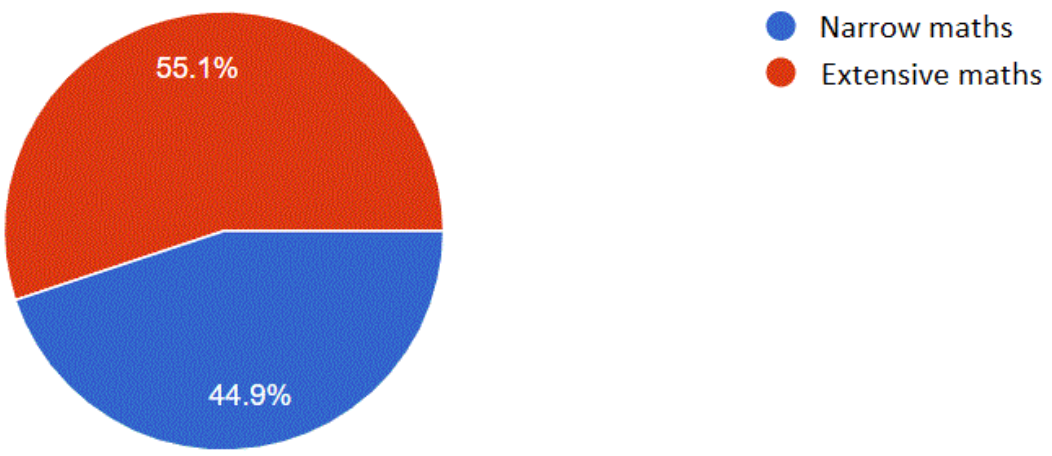


Figure 2.7. Distribution of the type of the final math exam

Over 50% of the students passed the extensive math exam, while narrow math exam passed 44.9% of students (Figure 7).

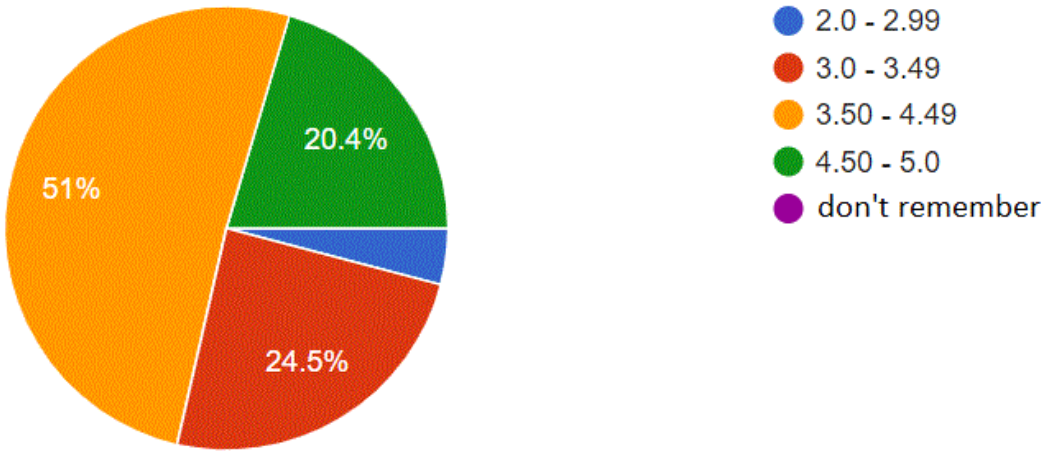


Figure 2.8. The average grade for mathematics in secondary school or equivalent.

Figure 8 reflects the average grade for the mathematic course in school. More than 20% (10 students) of the respondents answered, than their grade is over 4,5. If we compare these results with the grade for the final math exam (Figure 9), we can see that 21 students got for the final math exam less than 50 point. This can be interpreted as the math exam is more complicated, than pupils' abilities and knowledge on mathematical topics.

According to the figure 9, only 28 students got for the final maths exam 50 points or more.

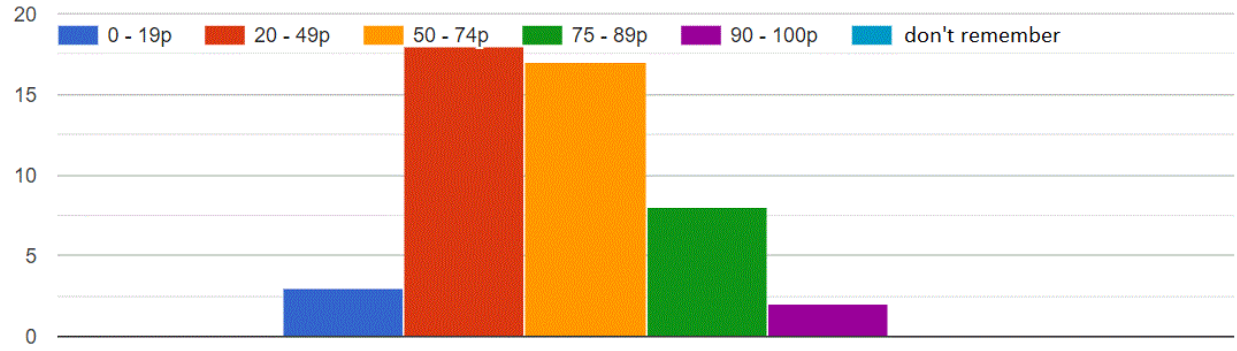


Figure 2.9. Student's final exam grade of mathematics

These results do not correlate well with the results of the question 11, where students asked to rate their prior mathematical knowledge. The majority of all students (43 out of 49) rated their prior mathematical knowledge over average: good -18 students, very good – 18 students, excellent – 7 students (Figure 10Figure).

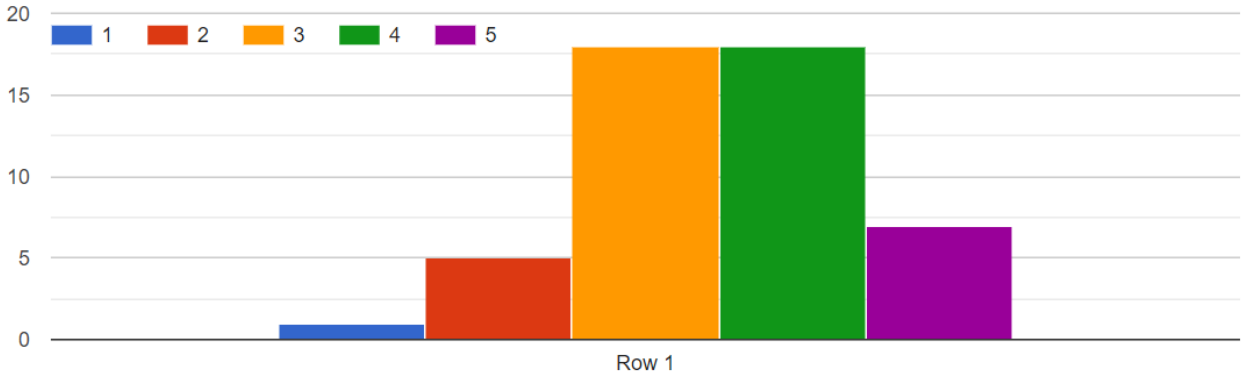


Figure 2.10. Students' rating of their previous mathematical knowledge

Survey analytics.

The questionnaire is divided by the topic into 7 sections and contains 38 questions. The first section (question 1-11) contents questions on evaluation of the background of the respondents. Second section (questions 12-21) focus on quality assessment of the maths courses. Section 3 (questions 22-23 contains question refer to competences of the maths lecturers. Question in section 4 and 5 (question 24-26) refer to teaching methods and resources used in teaching process (respectively). Section 6 asks question on general satisfactory with the mathematical courses. Section 7 consists of the open question.

Next set of questions below (questions number 12-21; 29-33) used the following scale:

1	2	3	4	5
Fully disagree	**disagree**	**not disagree but not agree**	**Agree**	**Fully agree**

Students were asked to rate mathematical courses: overall expectations, learning outcomes, teaching methods and literature used.

The mathematics subjects in Maritime Academy met the expectations for more than 57% students (Figure 11).

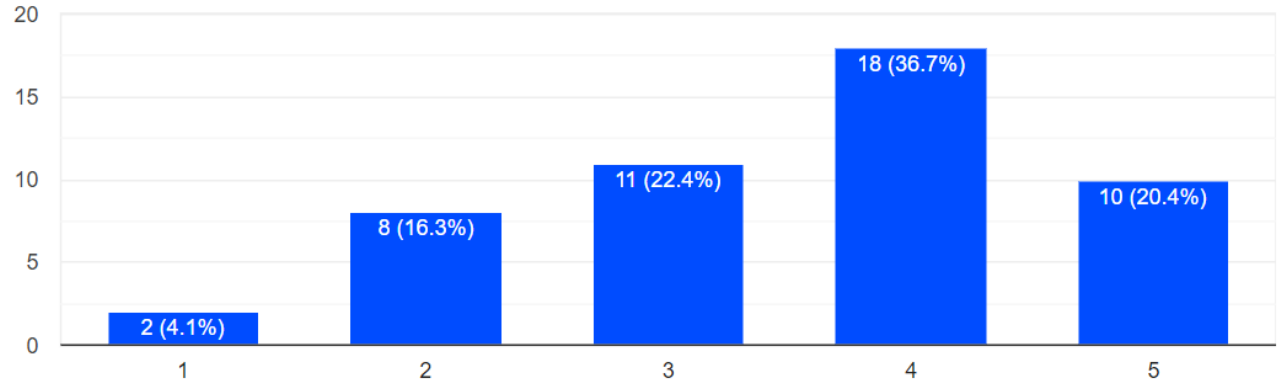


Figure 2.11. Students feedback on question 12 (see Questionnaire attached)

The analysis of the survey reveals that the learning outcomes of the maths subjects were clearly formulated (more than 60% agreed with this statement, Figure 12).

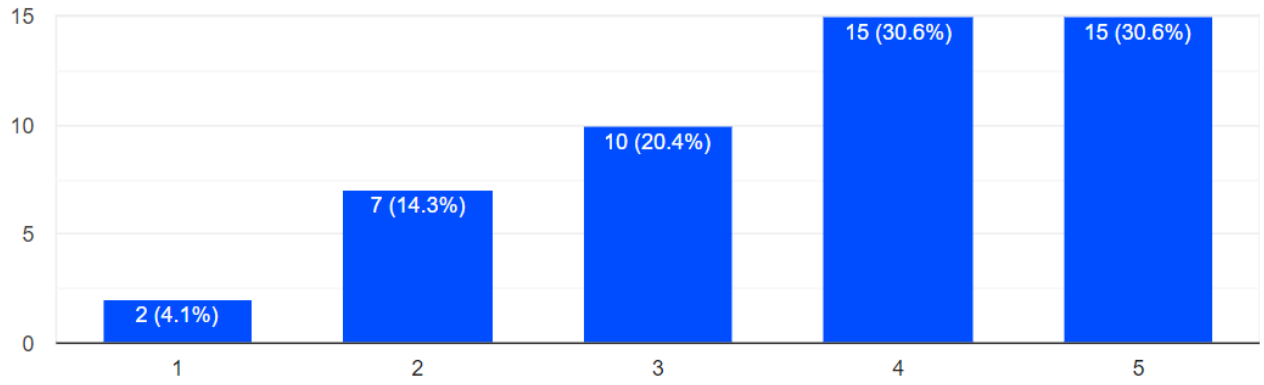


Figure 2.12. Students feedback on question 13 (see Questionnaire attached)

The evaluation criteria were clear for more than 80% of respondents (Figure 13)

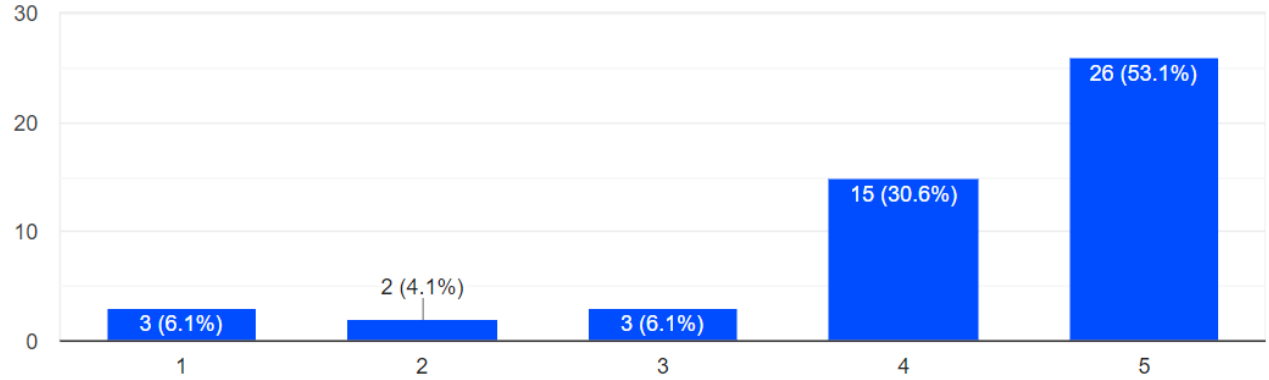


Figure 2.13. Students feedback on question 14 (see Questionnaire attached)

Survey analysis revealed, that teaching methods used by the teacher were not enough suitable and interesting (Figure 14).

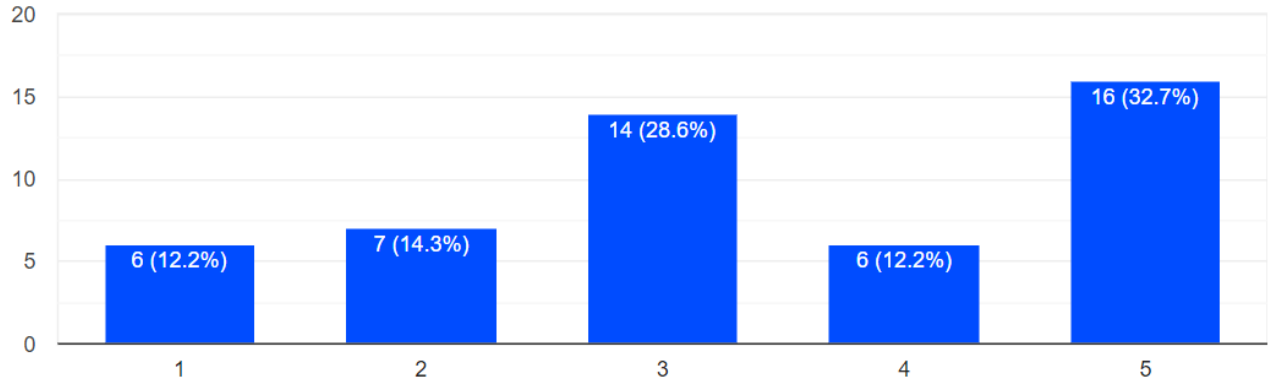


Figure 2.14. Students feedback on question 15 (see Questionnaire attached)

Question on the importance to participate in the classes in order to improve knowledge and prepare for the exam revealed, that more than 70% agreed with the statement (Figures 15-16).

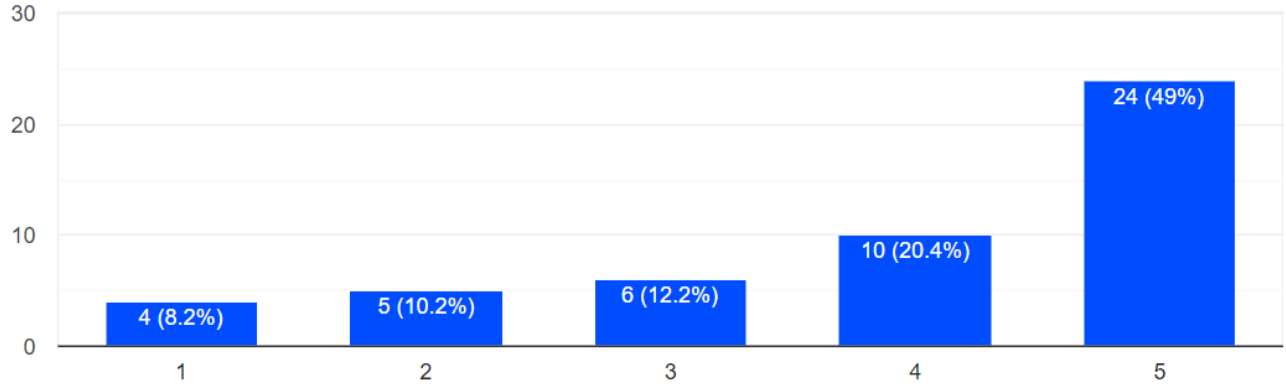


Figure 2.15. Students feedback on question 16 (see Questionnaire attached)

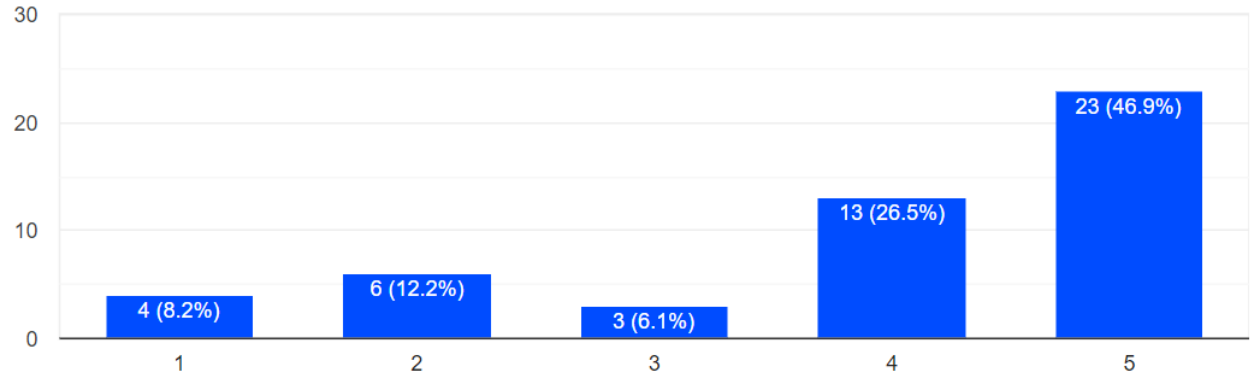


Figure 2.16. Students feedback on question 17 (see Questionnaire attached)

The same feedback from the students refers to questions 17-18 (Figure 17, 18). Students agreed that solving the exercises is useful and facilitates the preparation for the exam.

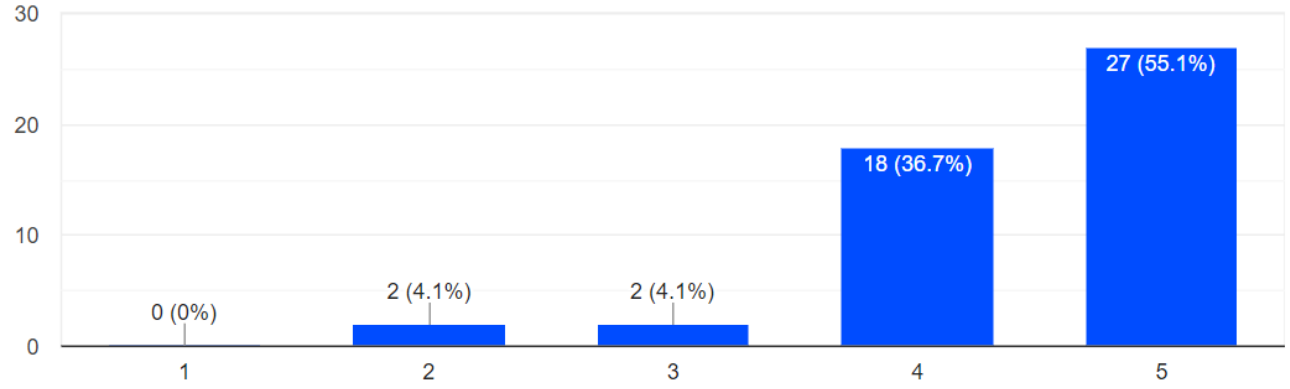


Figure 2.17. Students feedback on question 18 (see Questionnaire attached)

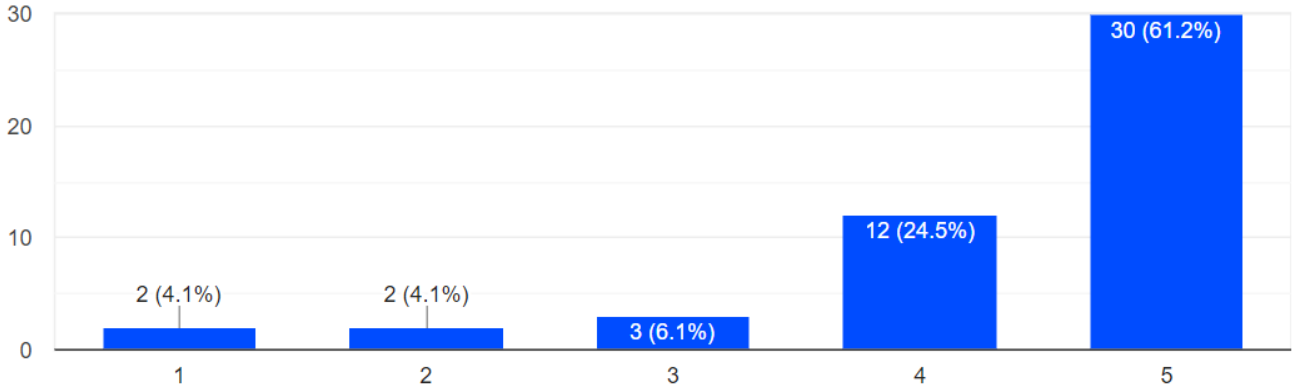


Figure 2.18. Students feedback on question 19 (see Questionnaire attached)

The questions 20 and 21 on literature provided showed, that students do not thing that the recommended literature was appropriate and useful for preparing for the exam: 20.4% (10 students) gave a neutral feedback, while 19 students disagreed with the statement (Figure 19).

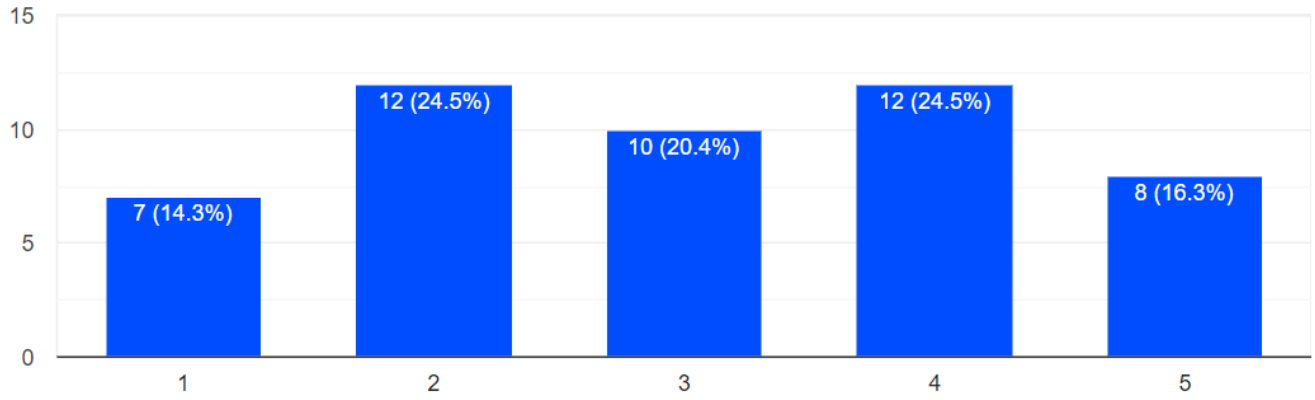


Figure 2.19. Students feedback on question 20 (see Questionnaire attached)

Figure 20 shows that despite of the results of the previous question, students marked that necessary literature was available (Figure 20).

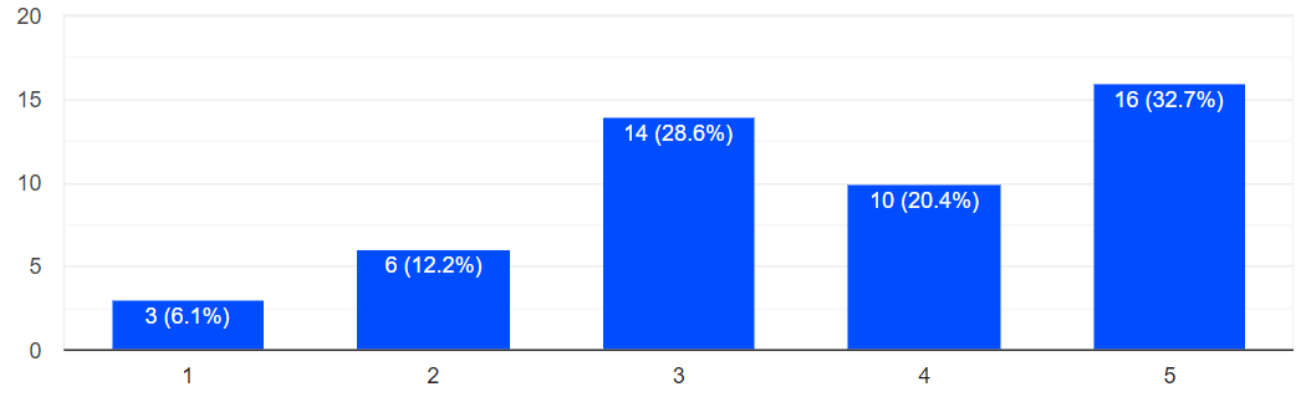


Figure 2.20. Students feedback on question 21 (see Questionnaire attached)

Figure 21 shows how students rate their experience and satisfaction with mathematics subjects they have participated.

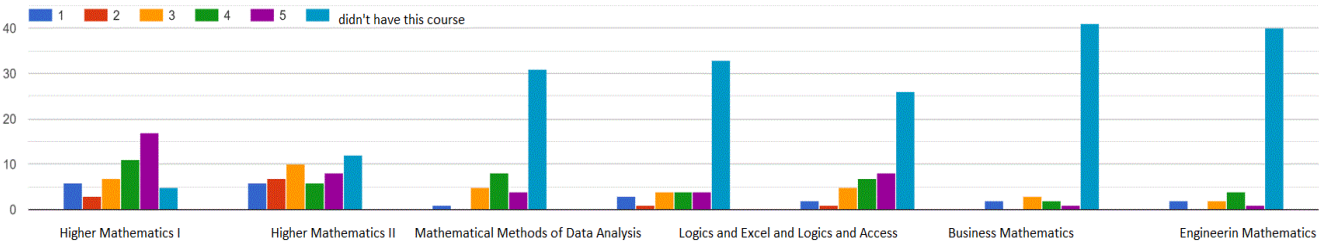


Figure 2.21. Students feedback on question 27 (see Questionnaire attached)

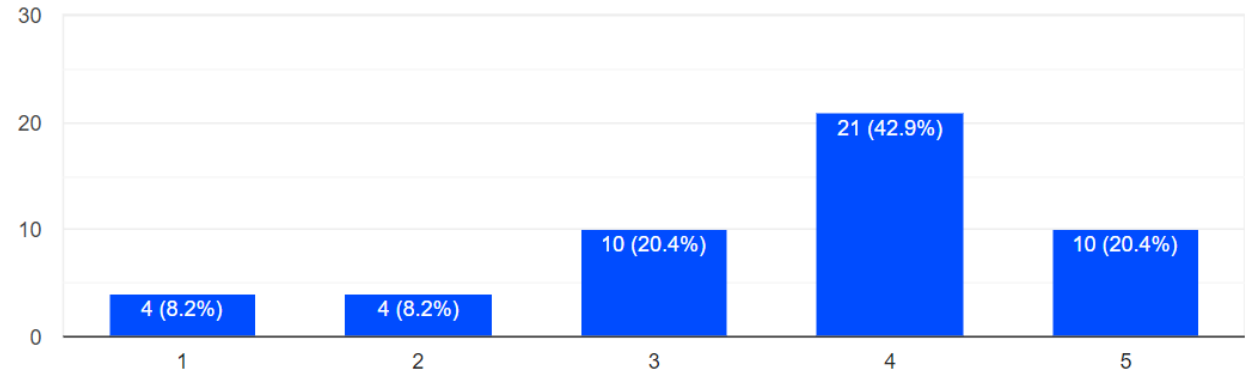


Figure 2.22. Students feedback on question 29 (see Questionnaire attached)

Students agreed that knowledge they have gained in mathematics and statistics is essential for their future work (Figure 22). In addition, 23 students agree that mathematics subjects developed their problem-solving and decision-making skills. 26,5% of respondents could not agree or disagree with the statement (Figure 23).

30.

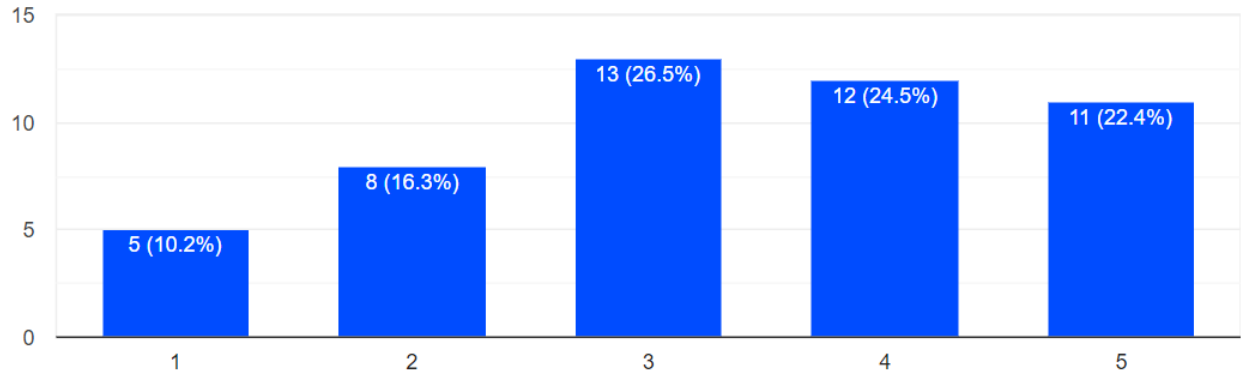


Figure 2.23. Students feedback on question 30 (see Questionnaire attached)

Surprising results demonstrate Figure 24. 29 of students (59,2%) totally disagree with the statement, that mathematics subjects developed their communication and presentation skills.

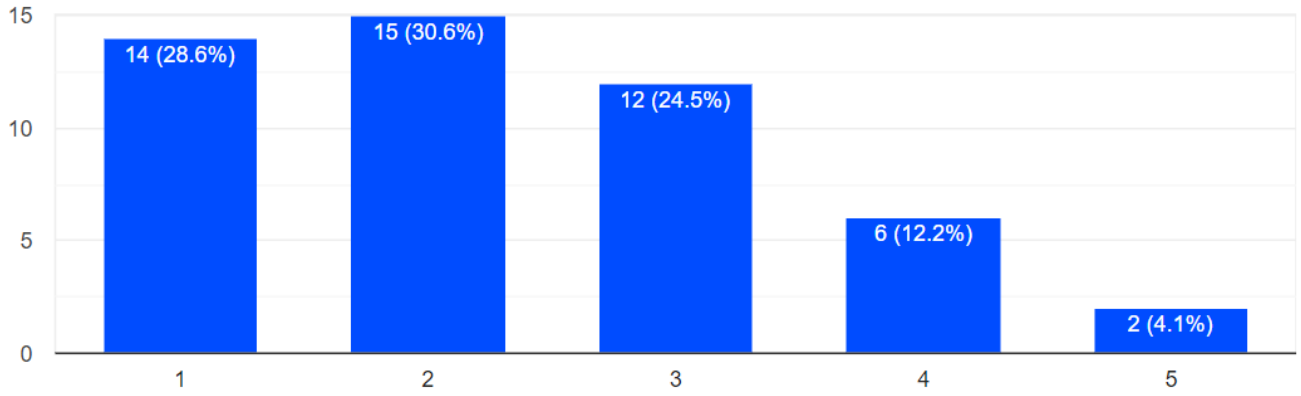


Figure 2.24. Students feedback on question 31 (see Questionnaire attached)

Very similar results is reflected in Figure 25, which shows that students do not think that mathematics subjects developed their teamwork skills. At the same time students mostly agreed that the mathematics subjects developed their ability to work independently (Figure 26).

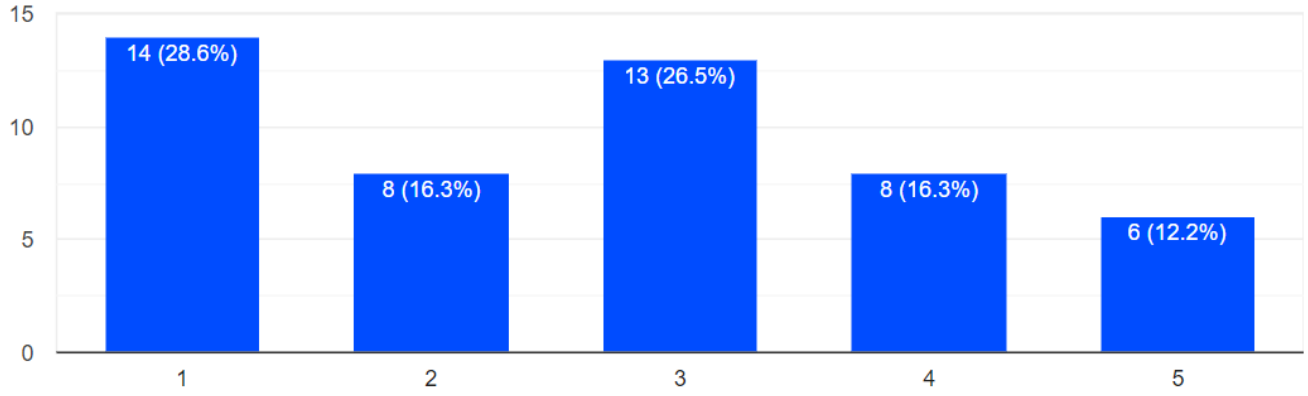


Figure 2.25. Students feedback on question 32 (see Questionnaire attached)

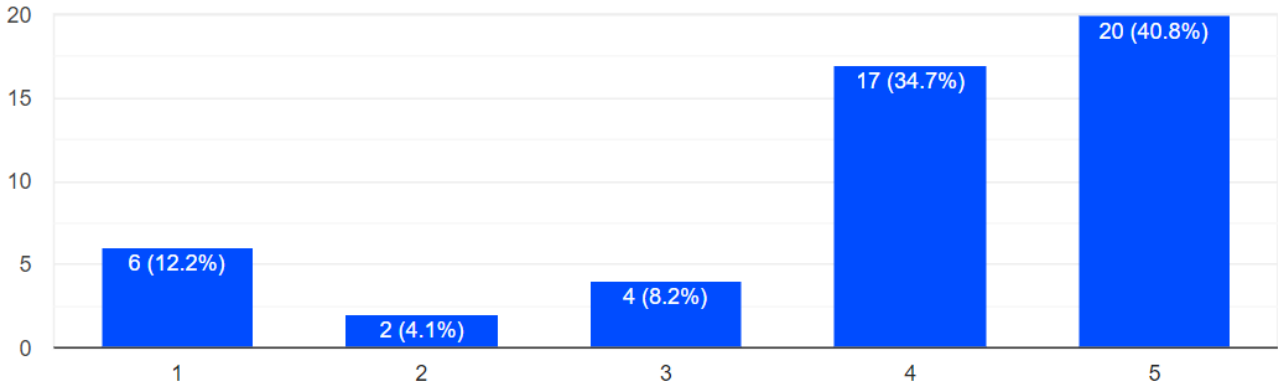


Figure 2.26. Students feedback on question 33 (see Questionnaire attached)

Comments and suggestions for improvement of teaching and studying process

The questionnaire includes open questions (questions 23, 26, 28, 34-38) where students had to leave a comment to the specific topic. The overview of the answers is presented below.

Question 23 asked to give a short feedback to teacher on his/her work. As this question was not mandatory, there were only 17 responses. Interpretation of the answers was difficult: students commented anonymously and it was not possible to identify to whom of three lectures in maths comments were addressed. Some students were satisfied with the teacher, others were complaining.

Question number 26 was on resources and tools used to support learning. The answers also reflected bias: some students were satisfied with the tools use by lecturer, others were disappointed. Probably students were commenting different teachers.

Concluding remarks on mathematics subjects (question 28) revealed that the lockdown caused by pandemic negatively effect to the learning process and e-tools used while this period did not facilitate learning.

Students liked much the proficiency of teachers and the overall organisation of maths courses (Question number 34).

Question number 35 was addressed to students in order to give suggestions for improvement of the mathematical courses. The main problem according to answers is the lack of contact hours, students need more explanation from the teacher on mathematical exercises. In addition, students complained that teachers do not take into account students' initial knowledge of maths. According to the comments, the additional elective course on mathematics would give an opportunity to students enrich their maths knowledge to the needed level. It is essential to merge theoretical materials with practical exercises closed to future speciality.

Question number 36 asked about the need to repeat previous topics before starting a new one. Majority found that some topics (e.g. integrals) need to be repeated before evaluation.

Question number 37 asked to suggest any topics that should be covered in the maths course, as this is important for student's future studies and work. The majority answers referred to statistics. Some of the students could not suggest any topic.

The final question number 38 asked about any improvements, which could facilitate learning and teaching mathematics. According to the opinion of the respondents, more advanced e-tools could be integrated to the study process.

Conclusion remarks

Despite of the overall positive feedback on the resources and tools used by teachers, the survey revealed, that due to the different level of the initial knowledge in mathematics students, not all of the respondents estimate the learning process as satisfactory.

On the one hand, teachers use advanced methods and tools to facilitate the learning process. On the other hand, students do not very motivated, as the importance of mathematics for their future profession is not clear for them.

It is important to seriously consider their comments such as: too much material and too little exercise, teacher do not consider student's prior knowledge on maths, etc.

In conclusion, there is a need to improve teaching and learning process and integrate advanced tools and methods into the teaching process.

Latvian Maritime Academy

Abstract

Overall, the average level of mathematics knowledge of high-school students has been decreasing for the last few years. This affects the quality of studies in technical universities. In order to eliminate the shortcomings of the study process, it was necessary to identify existing teaching tools and technical resources available at Latvian Maritime Academy. Surveys for mathematics teachers and students were developed to find out their views about the tools and needs to improve the teaching/learning quality. The questionnaire for mathematics teachers was completed 4 persons. There were 3 questionnaires developed for students: - about their learning habits, about quality of lessons, and about online lessons. 67 respondents completed the first questionnaire, 35 and 19 respondents answered the questionnaire about quality of lessons, and 79 persons completed questionnaire about online lessons. The collected data demonstrate that teachers and students have different viewpoints in several questions.

1 Introduction

The Mathematics study course forms the basis of knowledge for acquiring theoretical subjects of maritime study programs at Latvian Maritime Academy. Therefore, mathematics must be mastered at a sufficiently high level. However, a number of problems hinder this.

Students consider mathematics to be one of the most difficult subjects in their studies. There are several reasons for this view:

- Amount of information: the content of the subject is concentrated, each subsequent lecture introduces a new topic;

- Different teaching methods in secondary school and university: at the university great emphasis is placed on the student’s individual learning;

- Insufficient level of mathematics knowledge.

Such problems are obstacles for students to successfully complete the mathematics course taught using traditional teaching methods developed over time.

To improve the quality of studies, a deeper analysis was needed on the teaching aids and methods available at the Maritime Academy and their modernization in accordance with modern technical possibilities. It was also necessary to obtain students' feedback and assessment of the teaching/learning process.

1.1 Mathematics courses in Bachelor’s degree study program

The study process in Latvian Maritime Academy (LMA) is based on the standards set out by the STCW Convention. Study program of Bachelor degree in Latvian Maritime academy consists of several parts: subjects of general education, theoretical subjects of the field, maritime professional subjects, practice, and state examinations.

Four different courses of mathematics are included in the study program: three compulsory courses of Mathematics, Statistics, and Mathematical Methods of Economics. Mathematics courses are included in the part of general education (see table 1.1.1). The aim of the mathematics course is to give the basic knowledge necessary to acquire different subjects of specialty. The Statistics and Mathematical Methods of Economics courses are included in the part of theoretical subjects of the field. Additionally, an optional course Elementary Mathematics is offered for students who would like to strengthen their basic knowledge acquired in high school.

Mathematics course and Statistics and Elementary Mathematics subjects are taught by the mathematics teachers of General Department. The study course Mathematical Methods of Economics is taught by an invited guest lecturer.

Table 3.1.1. Mathematics courses in LMA

Study course	Semesters	Credit points (ECTS)	Bachelor's degree programs	Status
Mathematics	I, II, III	13.5	All	Compulsory
Statistics	IV	3	Ports and Shipping Management	Compulsory
Mathematical Methods of Economics	IV	1.5	Ports and Shipping Management	Compulsory
Elementary Mathematics	I	1	All	Optional

The basis course Mathematics has to be studied for three semesters of the first and second study years. First part of the mathematics course gives the introduction to Pre-calculus observing topics Complex numbers; Particular questions of linear algebra; Vectors; Analytic geometry, and introduction to Calculus including: Functions; Limits; Derivation of functions; Differentials; Application of derivatives. The Mathematics course for second semester includes the following topics: Indefinite integrals; Definite integrals; Application of definite integrals; Multivariable functions; Ordinary differential equations. The third semester Mathematics course considers topics of Series, Multivariable integrals, and Line integrals. As a result of successful completion of the study course, students can earn 13.5 credit points in European Credit Transfer System (ECTS).

The courses Statistics and Mathematical Methods of Economics are included only in the Port and Shipping Management study program in the fourth semester. The Statistics course includes topics of Events and Probability; Discrete random variables; Continuous random

variables; Elements of mathematical statistics. The subject Methods of Economics includes topics on Theory of interest rate; Payment flows; Tasks of linear programming, their compilation and solving methods.

The optional course Elementary Mathematics is developed for students who need to strengthen their mathematics knowledge of high school level.

1.2 Type and form of mathematics lessons, teaching aids, and technical support

Latvian Maritime Academy provides a traditional way of teaching mathematics. Two types of classes are conducted: theoretical lessons and practical classes. During theoretical lessons the lecturer presents theoretical materials, shows explanatory examples, and demonstrates different methods of problem solving. In practical classes students do exercises and solve problems in connection with the topics discussed during the theoretical lessons. This work is guided by the teacher. Students do individual works on each topic (individual homework) and after each topic they have tests. At the end of the semester, students have to write a mathematics exam. A student is admitted to exams only if all individual works and tests have been done successfully. The student is allowed to sit for the exam three times, but if he or she has not passed the exam on the third time, he or she cannot can continue full-time studies. Some of students take the opportunity to enter part-time studies.

Mathematics textbooks, exercise and problems books, and handbooks published in Latvia are available to students. Lecture notes and examples of problem solving developed by local mathematics teachers are published by LMA. These lecture notes for all topics included in mathematics course are available online too. Different internet materials are recommended for students for their individual studies.

Almost all classrooms are equipped with a computer for the teacher and with a LCD projector.

1.3 Students' enrolment in Latvian Maritime Academy

The number of students who enrolled in full-time studies at LMA in the year 2018 was 122, in study programs Marine Transport – Navigation (MN), Ports and Shipping Management (PSM), Maritime transport – Marine Engineering (ME); Marine Transport – Marine Electrical Automation (MEA). There were only one student who re-enrolled from a year of academic leave in Management specialisation.

Table 3.1.3.1. Number of students who enrolled at LMA in 2018 by gender

Undergraduate studies	Enrolled students	Male	Female
Maritime Transport - Marine Engineering	27	27	-
Marine Transport - Navigation	65	59	6
Marine Transport - Marine Electrical Automation	9	9	-
Ports and Shipping Management	21	6	15
Grand Total	**122**	**101**	**21**

Traditionally female students enter navigation or management programs. More female students chose management study program than male students (see table 1.3.1).

The compulsory courses Mathematics I and Mathematics II must be studied in the first and second semesters. The compulsory course Mathematics III must be studied in the third semester. All these subjects must be accomplished by a final exam at the end of every semester.

Table 3.1.3.2 Students who enrolled at LMA in 2018 and passed mathematics exams of first and second semesters

	Mathematics I					Mathematics II				
Study programs	**Enrolled students**	**Pass (C)**	**Leave studies**	**Part-time**	**Pass (%)**	**Enrolled students**	**Pass (C)**	**Leave**	**Part-time**	**Pass (%)**
ME	27	19	3	5	70%	19	13	6		68%
MN	65	55	10	2	85%	51	47			92%
MEA	9	7	2		78%	7	2	5		29%
PSM	21	18	3		86%	18	17		1	94%
Grand Total	**122**	**99**	**18**	**7**	**81%**	**95**	**79**	**11**	**1**	**83%**

Table 3.1.3.3. Students who enrolled at LMA in 2018, and passed math exam in third semester

Mathematics III (third semester in study year 2019/2020)

Study programs	Enrolled students	Pass (C)	Leave	Part-time	Pass (%)
ME	13	13			100%
MN	42	42		1	100%
MEA	2	2			100%
PSM	17	15	2		88%
Grand Total	**72**	**70**	**2**	**1**	**97%**

Tables 1.3.2 and 1.3.3 show that of the 122 students enrolled at LMA in2018, only 70 students can continue full-time studies. Students leave studies due to various reasons. For instance, 10 students of navigation specialisation left academy in the middle of the first semester; they did not pass any of study subjects, not only mathematics.

1.4. Students' preparedness for successful acquisition of Mathematics

The overall mathematics knowledge of high school students in Latvia is decreasing in the last few years. The average result of the Centralized Mathematics Exam (CEM) was 32.7% in school year 2018 - 2019 according to the data given by National Centre for Education. It is less than the previous year's average result 34.6%. Similarly, it is possible to compare CEM results of students enrolled in Latvian Maritime Academy. The average Centralized Mathematics Exam result of enrollers in 2018 was 45% among 122 persons, while in 2019 it was only 23.5% among 150 persons. Comparing the results between the target groups that have score less than 11%, between 11% and 20%,…, 91% and 100%, it can be seen that there were more students with score below 40% in 2019 than in the previous year (see figure 1.4.1).

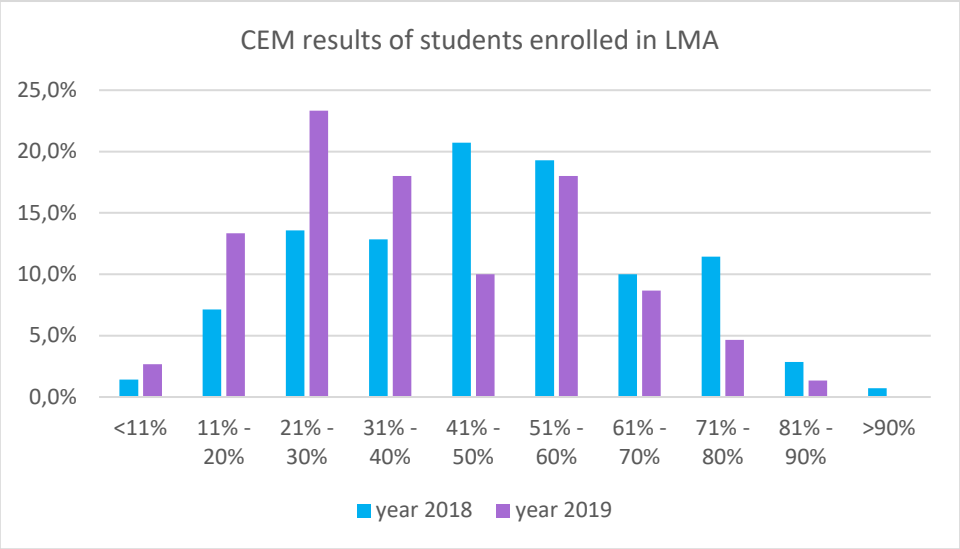


Figure 3.1.4.1. CEM scores of students enrolled at LMA in 2018 and 2019

Such results indicate that a significant part of students cannot fully master new study material. This problem faces all universities of natural sciences and technical sciences. It is a challenge to bridge the gap in transition from high school to university. Different levels of students' preparedness cause problems in the work of teachers. Some serious errors persist even from the primary school level.

The teachers at LMA collected characteristic errors from students' homework and tests during a couple of years. Tables 1.4.1, 1.4.2, 1.4.3 show examples about opening the brackets, ignoring priority of arithmetical operations or properties of whole numbers. Other hard topics are operations with fractions and powers, and transformation of algebraic expressions (see tables 1.4.1, 1.4.2, and 1.4.3)

Table 3.1.4.1. Characteristic errors of LMA students that relate to primary and lower secondary school level

Grade	Strand	Examples of errors
3	Priority of arithmetical operations and use of brackets	$c-(a-b)=c-a-b$ $3+2\cdot 4=5\cdot 4$
4	Commutative, distributive and associative laws of arithmetical operations	$(3+2)\cdot 4=3+2\cdot 4$
5	Properties of whole numbers	$-2(a+3)=-2a+3$ $-2(a+b)=2a+2b$
5	Operations with fractions	$\frac{1}{2}+\frac{1}{3}=\frac{2}{5}$ *or* $\frac{1}{5}$ $\frac{1/2}{4}=2$ $\frac{1}{3}-\frac{1}{2}=\frac{1}{3-2}=1$

6	Estimation of real numbers	$\frac{1}{27,5} < 10^{-3}$

Table 3.1.4.2. Characteristic errors of LMA students that relate to upper secondary school level

Grade	Strand	Examples of errors
7	Operations with powers	$\frac{a^8}{a^4} = \frac{8}{4} = 2$ $\frac{3^x}{2^x} = \frac{3^1}{2^1} = 1,5$
7	Algebraic transformations	$4 + 3x + x^2 = 4(3x + x^2)$
7	Solution of linear equations	$2x = 3 \Rightarrow x = 3 - 2 = 1$ $\frac{x}{4} = 3 \Rightarrow x = \frac{3}{4}$
8	Representation of square root	$\sqrt{4+9} = 2 + 3$
8	Factorization: special formulas	$(a \pm b)^2 = a^2 \pm b^2$ $a^3 \pm b^3 = (a \pm b)^3$
8	Transformation of algebraic fractions	$\frac{1}{a+b} = \frac{1}{a} + \frac{1}{b}$ $\frac{a+b}{a} = b$

Table 3.1.4.3. Characteristic errors of LMA students that relate to high school level

Grade	Strand	Examples of errors
10	Properties of powers with rational exponents	$a^{-2} = \sqrt{a}$ $\sqrt[3]{a} = a^3$ $\frac{1}{a^2} = a^{1/2}$ $\sqrt[3]{\sqrt{a}} = ?$ $\frac{\sqrt{x}}{x} = ?$

10	Properties of logarithms	$\log_2 a = a\log_2$ $\log_2(a \pm b) = \log_2 a \pm \log_2 b$ $\frac{\lg a}{\lg b} = \lg \frac{a}{b}$
11	Trigonometric functions and transformation of trigonometric expressions	$\sin(a \pm b) = \sin a \pm \sin b$ $\sin 3a = 3\sin a$ $\frac{\sin 2a}{\sin a} = \frac{2\sin a}{\sin a} = 2$ $\frac{\sin t^2}{\cos t^2} = \frac{\sin}{\cos}$

2 Teachers' and students' surveys

In order to specify the teaching/learning tools and technical means at the disposal of LMA, as well as to identify the needs for improving the quality of the study process, the following surveys were conducted. One of the surveys was elaborated for teachers by the coordinators of MareMathics project. One survey was conducted about the students' learning habits in autumn 2018. Two questionnaires for students' feedback about the quality of mathematics lessons were conducted by Study Department in spring and in autumn 2019. The last questionnaire was given to students in spring 2020 to assess their views on distance learning.

2.1 Target groups

In February 2020 four LMA mathematics teachers (one male and three female respondents) completed the survey "Math teacher questionnaire" offered by the coordinators of MareMathics project. Two were currently working teachers (associated professor and lecturer), and two retired teachers who worked with students in the study year 2018-2019.

To analyse students' learning habits and time distribution devoted to learning, there were questioned 67 first semester students who studied in Navigation study program and Port Management study program (20 of respondents were female).

The Study department conducted two surveys about the study course Mathematics II at the end of the spring semester 2019 and about study course Mathematics I at the end of the autumn semester 2019. Questionnaire about the course Mathematics I was completed by 35 first year students in Engineering specialisation. Questionnaire about the course Mathematics II was completed by only 19 respondents from the 48 invited first year students in Navigation specialisation.

The last short questionnaire about the online mathematics lessons was developed by LMA lecturers. 79 respondents of navigation, port management, electrical automation, and engineering specialisations were questioned in second semester 2020.

2.2 Teachers' questionnaire

2.2.3 Participants

Three mathematics teachers worked in the study year 2018-2019: a professor, an associated professor, and a lecturer. The associated professor retired in spring 2019. The professor retired in January 2020. A new associated professor started her work in LMA in September 2019. Two mathematics teachers actively work with students in second semester of study year 2019-2020. All four teachers completed the survey "Math teacher questionnaire".

Three respondents had significant pedagogical experience in a higher education institution - more than 15 years, one had experience less than 10 years. Only one of them had completed a teachers' education program.

2.2.4 Sign, literature, exams

The data of this part of questionnaire characterizes teachers' work style that is mostly traditional.

All teachers inform students about the goals, learning outcomes, grading criteria and evaluation methods before starting the math course. Three of them do this orally in the introductory lecture and one in writing.

As literature for the students, teachers most often recommend lecture notes produced by LMA itself. Some of the teachers are authors or co-authors of these lecture notes. Often textbooks from other universities, teaching materials and learning resources published on the Internet are recommended.

For distributing other materials to students (presentations, student's tasks, past exams...) the internet is used widely. Most teachers use email for this purpose (75%). Teachers use also Faculty's website and e-learning platform OMARS that is elaborated on the basis of Moodle. Only one teacher doesn't use internet for this purpose at all.

The computer and LCD projector (50%) and tutorial software or practice programs (50%) are often used in lessons. One person uses e-learning system.

Mathematics exams are organized in two ways, either exclusively as written (50%) or as combined written and oral exams (50%).

2.2.5 Teaching quality

Respondents were asked to evaluate their agreement with the proposed statements on a scale from 1 to 5 (1 – strongly disagree; 5 – strongly agree).

Most teachers consider that the space and technical conditions are well or very well appropriate to the teaching needs (75%) and only one lecturer (25%) considers that space and technical conditions are very bad for teaching.

Most respondents acknowledged that the availability of teaching aids fully meets the needs of the course (75%), while one considers the availability of teaching aids as not so good.

Collaboration among the mathematics teachers is mostly assessed as successful, as only one person assessed the collaboration as not so good.

Half of the teachers think that the number of students is not well aligned with the available teaching capacity, but one teacher assesses this as good and other one assesses this as very good. Assessing the preparation time available for teachers, half of the teachers consider that they do not have enough time, and half answered that they have enough time.

All teachers often or very often explain a matter again if it is not clear to students during the class.

2.2.6 Activities of students

Teachers have observed that students rarely (50%) or never (50%) work in small groups to come up with a joint solution to a math problem, although this is encouraged. In addition, all teachers mention that students rarely (50%) or never (50%) work on computer in math course and students rarely (25%) or never (75%) solve real-world problems (linking theory and practice).

Teachers either only give homework to students or combine online tests with homework. It depends on the lecturer how often students complete online tests and quizzes. One teacher gives online tests very often, one rarely and two never do this. At the same time, all teachers assign homework to students. Most teachers (75%) give it very often and almost all teachers (75%) require the students to submit and comment their completed homework often.

2.2.7 Teacher's assessment of student's performance and behaviour

All teachers assess students' prior knowledge which is important to understand the content of the mathematics course. They acknowledge that students' knowledge is quite mediocre or satisfactory.

All lecturers consider that students are interested in the math courses and note that students often ask teachers to explain a matter if it is not clear to them. Students attend classes sufficiently well, and most teachers (75%) consider that students regularly prepare for classes.

All teachers rate their relationships and communication with students as good or very good.

Half of the respondents noted that students actively participate in learning, but the other half assess the activity of the students only as satisfactory.

At the same time teachers consider that students are not sufficiently responsible for their duties. Most teachers (75%) rate the statement „The students complete their duties on time" as unsatisfactory or as almost satisfactory.

Survey results show that students independently search additional information sources for learning materials (50% of teachers rate this „satisfactory" and 50% „good" or „very good").

75% of teachers are not satisfied or are almost satisfied with the percentage of students passing the math course. As the main reason for the achieved passing rate teachers identify the students' low level of prior knowledge in mathematics and irregular individual work. Teachers have observed that some students have problems in transition from high school to the study process of the university level.

Teachers note that to raise the passing rate of math courses it would be better to have more contact hours for practical mathematics classes. They suggest that students regularly make their homework and individual studies, and attend consultation hours with the lecturer. Some teachers also recommend students to do their individual studies in small groups where at least one of them is an expert in mathematics.

Almost all lecturers (75%) grade their own performance in teaching as high in the previous academic year 2018-2019 and one teacher rates it as satisfactory.

2.3 Questionnaire about students' learning habits

Mathematics lecturers composed the questionnaire about the students' learning habits to understand the division of time devoted to learning mathematics in autumn semester of study year 2018-2019. There were questions on students' beliefs about which of the learning ways can give more benefit to them. The questionnaire included questions of how they value the time spent learning alone, in groups, in consultations with the university teacher or with a private tutor, and in classes, and what benefit they have from these activities. Special attention was paid to the individual learning (learning alone): how students value their reading of mathematics theory books, using of notes made themselves, doing homework, solving additional exercises to better understand the themes, using computer technologies. Another question was how much time per week they need for learning mathematics.

2.3.1 Students' results on Centralized Exam of Mathematics

About the study course Mathematics I there were questioned 67 students from first semester who studied in Navigation study program and Port Management study program. Mathematics teachers found that more than 46% of respondents have quite average or below-average score on Centralized Exams of Mathematics (see figure 2.3.1.1). Low level of mathematics knowledge that students bring from high schools contribute to the difficulties that students face in studies in general. It is one of the reasons why students leave studies or do not pass exams.

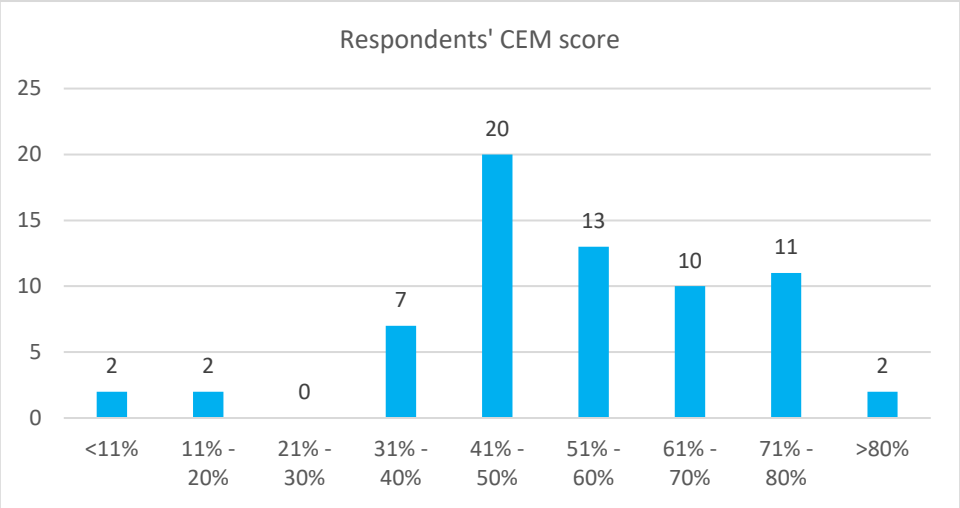


Figure 3.2.3.1.1. Number of students by percentile according to CEM score in 2018

To compare the students' beliefs and their attitude to the study process, respondents were separated into seven percentiles in accordance with their CEM score. The first group includes students with score below 21%. There were no students who got CEM score between 20% and 30%. The second group included respondents with exam score between 31% - 40%. The last group included students who gained a score above 80%. The average result of the questioned students on Centralized Exam of Mathematics was 54.16%.

2.3.2 Students' ways of learning

Students valued the learning in person in lectures and in practical classes of mathematics where they are doing a lot of exercises. As shown in figure 2.3.2.1 students do not always work effectively attending the classes. More than a third of students acknowledged that they need consultations with private tutors. Not all students took advantage of regular consultations with their mathematics teacher. They underestimated teamwork as well. Only 66% of respondents answered that they learn individually a lot or often. It means that these students devote enough time and effort to mathematics studies.

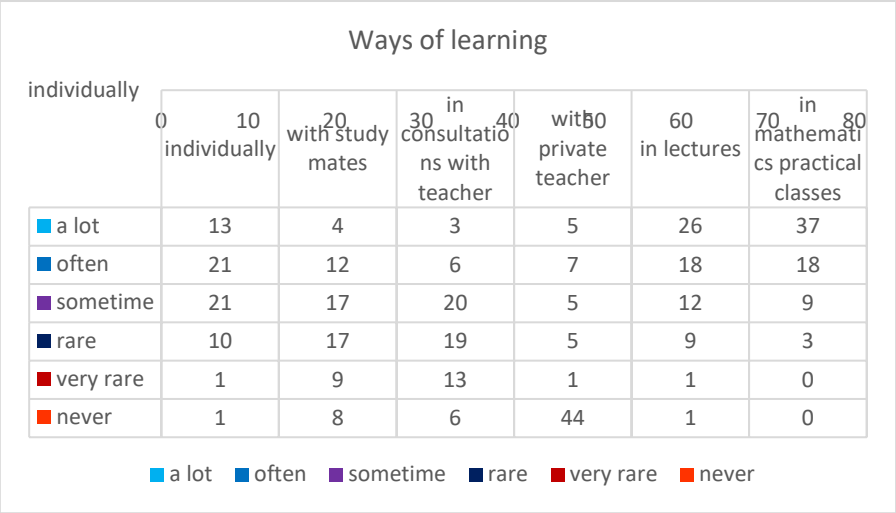


Figure 3.2.3.2.1. Students' ways of learning mathematics

2.3.3. Benefit from learning

Figure 2.3.3.1 shows how students valued their individual work. Students with higher CEM score valued their individual work better than other students. A significant indicator of the students' self-estimation is the fact that 45% of respondents considered that they have little or no benefit from individual learning. That means that they needed additional support in learning.

Another important indicator shows the benefits that students gain from lectures and classes of practical work. Respondents see higher benefit from practical mathematics classes than from theoretical lectures (see figures 2.3.3.2 and 2.3.3.3).

Theoretical topics were better understood by students with higher CEM scores. Students with lower scores had gaps in their knowledge of mathematics and therefore had not comprehended all details included in the topics presented.

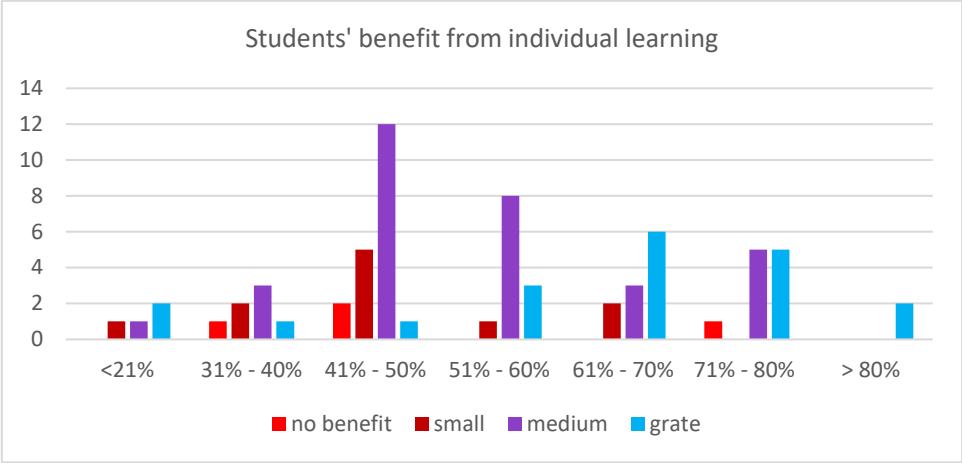


Figure 3.2.3.3.1. Students' evaluation of their individual learning by CEM score percentile

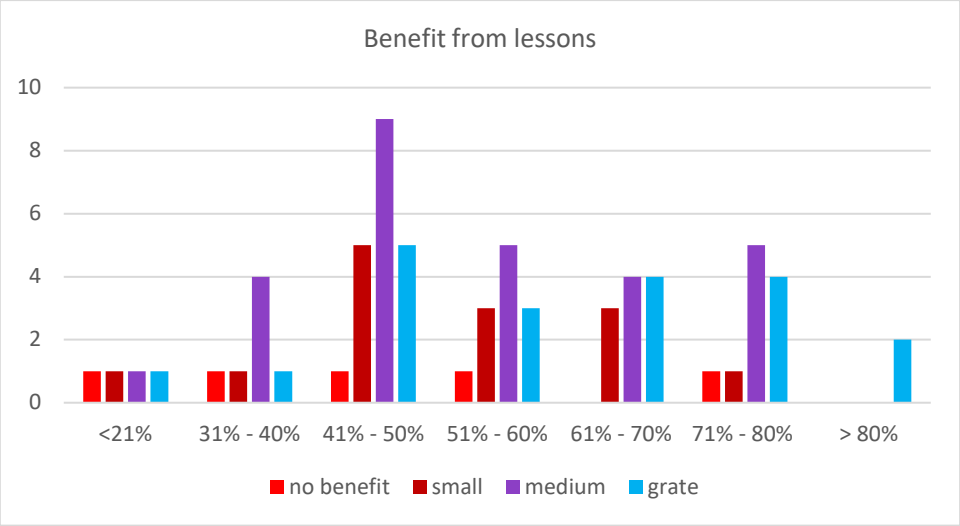


Figure 3.2.3.3.2. Students' benefit from mathematics lessons by CEM score percentile

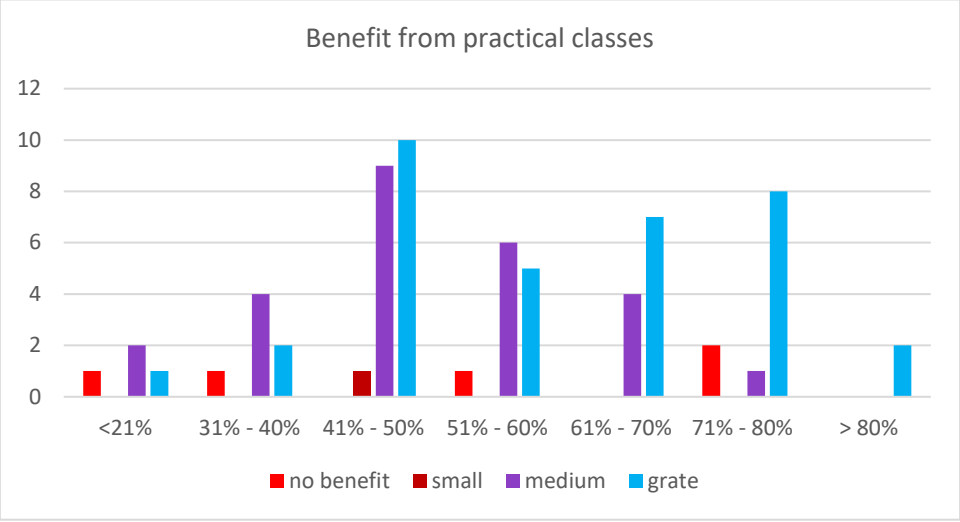


Figure 3.2.3.3.3. Students benefit from mathematics practical classes

2.3.4 Time devoted for learning

When asked to evaluate how much time per week students need for learning mathematics individually almost all students noted that they need significantly more time (approximately 5 hours on average) as planned in the study program (3 hours per week for studying mathematics individually). Looking closer to the percentiles of respondents with different CEM scores one can see that students with better prior mathematics knowledge did not spend less time learning as other students.

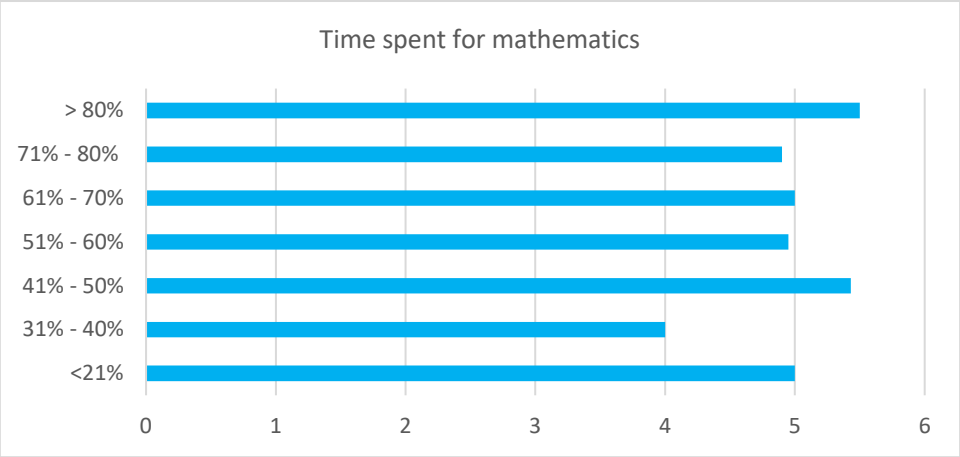


Figure 3.2.3.4.1. Average time that students spent for individual learning of mathematics per week

2.4 Questionnaire about the quality of lessons

The Study department has developed a survey that helps assess the quality of lessons from the students' perspective. This feedback also gives an opportunity to lecturers to make a self-estimation of the work performed. There were carried out questionnaires about two study courses Mathematics I and Mathematics II that were completed by 35 and 19 students, respectively.

The questionnaire includes some general questions like “How do you value this study course in general?”; “Were the goals and results of this study course clear for you from the beginning?”; “How much did you gain from this study course?”; “Is the workload in this study course too high?”

Other questions are focused on the working style of the lecturer.

Opinions about the study course Mathematics differ between the students of navigation specialisation who are taking the course Mathematics II and marine engineering specialisation who are taking the course Mathematics I (see figures 2.4.1 and 2.4.2).

Traditionally in the last few years the more popular study program in LMA is navigation, where more students enrolled than in engineering study program. Students enrolled in navigation specialisation are better prepared for studies than students enrolled in engineering – they have higher scores in centralized exams in general, thus they face less difficulties in mathematics classes.

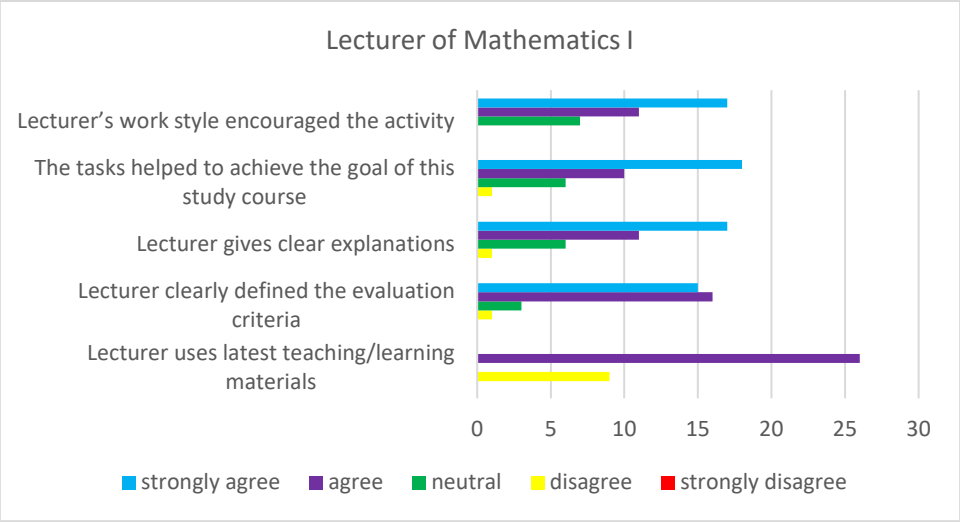


Figure 3.2.4.1. Students' opinion on the quality of Mathematics I classes

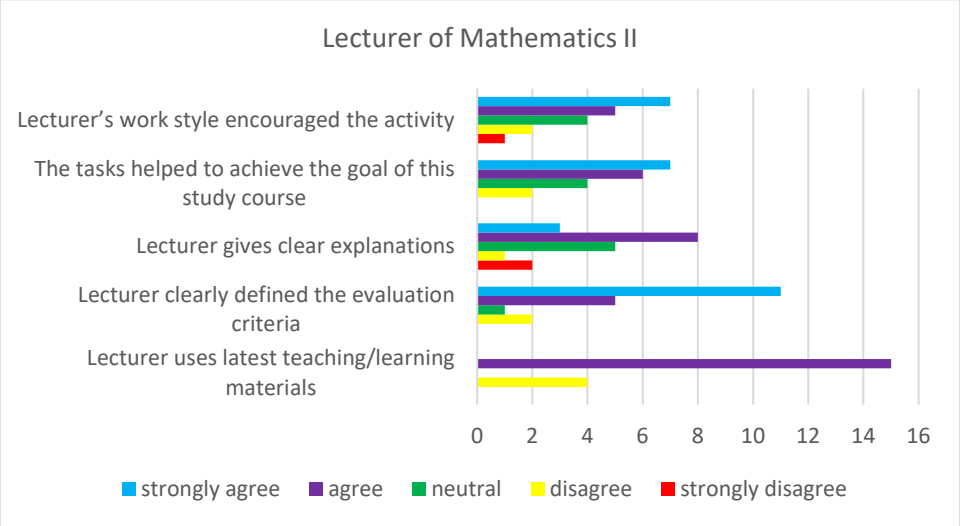


Figure 3.2.4.2. Students' opinion on the quality of Mathematics II classes

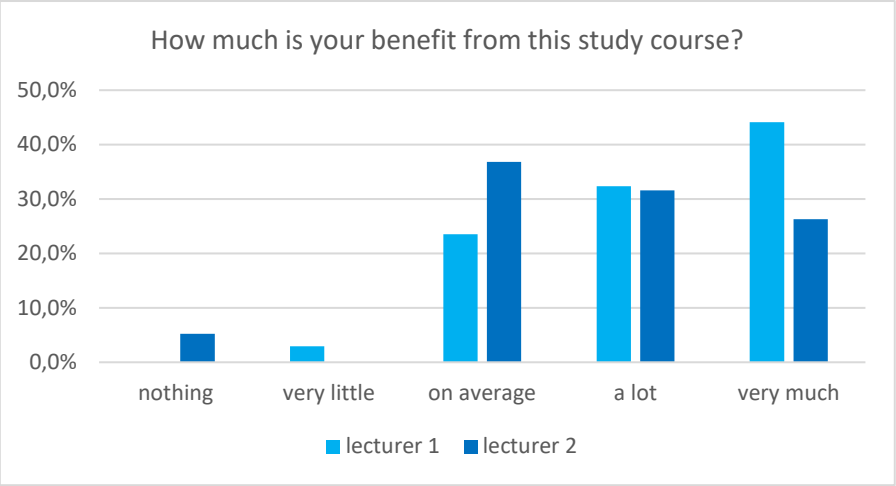


Figure 3.2.4.3. Students' self-assessment of acquired knowledge

Comparing the results of these two questionnaires one can take into account the fact that navigation students completed a more difficult part of mathematics course in second semester than did engineering students in the first semester. Therefore, they value lecturers' explanations of topics and tasks differently. 20% of students of the first semester disagreed or had a neutral position as to whether the lecturer gives a clear explanation. The same opinion was held by 42% of students who studied Mathematics II. These opinions correlate with the students' assessments of benefits gained (see figure 2.4.3).

2.5 Students' benefit from online mathematics lessons

LMA lecturers invited students of second semester of study year 2020 to complete a short questionnaire about online mathematics lessons. 79 respondents completed this questionnaire. The aim of the questionnaire was to ascertain students' benefit from the mathematics lessons in the new form of communication. From the middle of March lectures were organized online. It was a challenge for lecturers and students both. Video communication platform Zoom was used for lessons and consultations. It gives the possibility to apply different programs like GeoGebra, Desmos Graphing Calculator, MS Excel, different scientific calculators, etc. Therefore, one of the questions was about the technical resources used in presentations.

The questions included in the questionnaire were valued on a 5 point scale: 1 – very poor; 2 – poor; 3 – fair; 4 – good; 5 – very good.

Students acknowledged that they understand new topics of mathematics better when explained in person. Only 28% of respondents were happy with the online lessons (see figure 2.5.1). Most students rated as good and as very good the opportunity to have online consultations.

Figure 2.5.2 shows that only 7.6% of students asserted that they do not need detailed explanations of the topics and tasks included in the lectures.

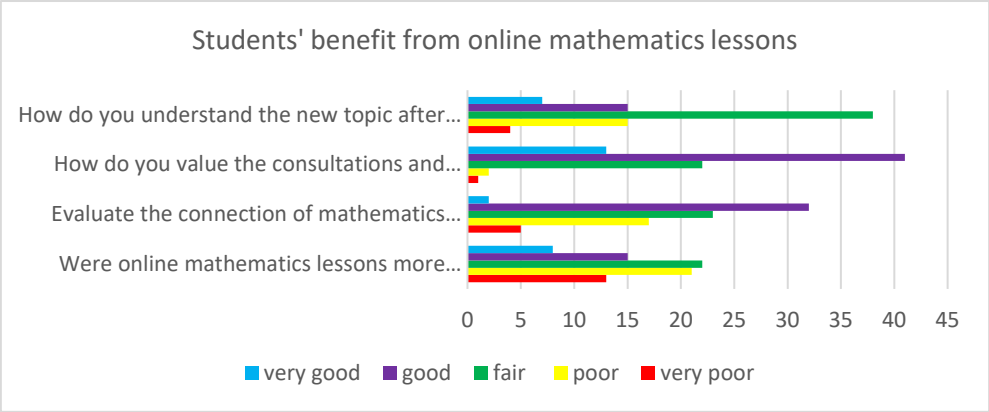


Figure 3.2.5.1. Students' benefit from online mathematics lessons

Students admitted that it is much more difficult for them to study online than in the auditorium, they could not actively consult with mates, and could not actively ask questions to the teacher.

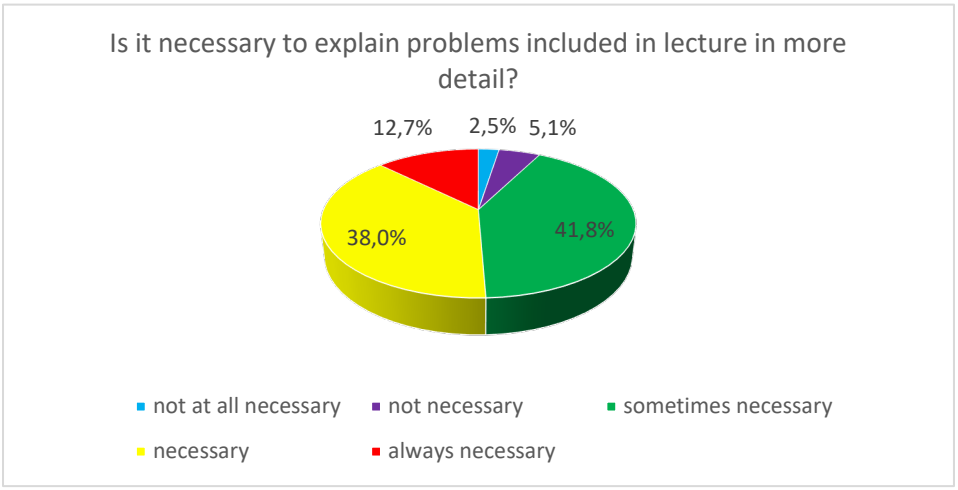


Figure 3.2.5.2. Students' assessment about their understanding of problem solving

3 Comparative analysis of needs to improve the quality of teaching/learning process

Comparing the results of the conducted surveys, it can be seen that there is certain discrepancy between the opinion of teachers and the views of students. When evaluating the opinions about the aims and results of the mathematics course, a significant part of students admits that they were not clearly understood. These were 11.5% of those studying Mathematics I course and 53.6% of those in Mathematics II (see figures 3.1 and 3.2) as one can see from the data gained in questionnaires about the quality of lessons. Despite the fact that the material of the second semester is more complicated, the teacher must formulate

more clearly the goals of the course. According to these results it is necessary to keep such general information accessible to students in intranet.

Speaking about the general conclusions, teachers valued their contribution in teaching work as very good (25%), as good (50%), and as fair (25%)(by Math teacher questionnaire). What is the students' benefit from the mathematics lessons? Students valued more highly the practical mathematics classes of doing exercises and solving problems than theoretical lessons (data from survey on the students' learning habits). 28.4% of respondents acknowledged that they have little or no benefit from lessons at all. Only 8.6% of students believed that they have no benefit from practical classes. In the survey of the Study Department, students expressed their opinion on how much they have acquired in mathematics course. Respondents in Mathematics I agreed that they learned much and very much (74.3%), while in Mathematics II the same opinion was shared by 57.9%.

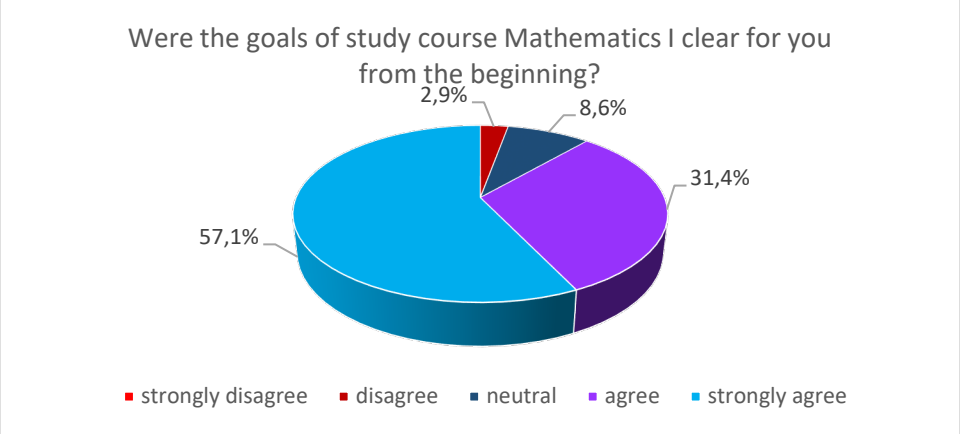


Figure 3.3.1. Students' evaluation of the course Mathematics I in general

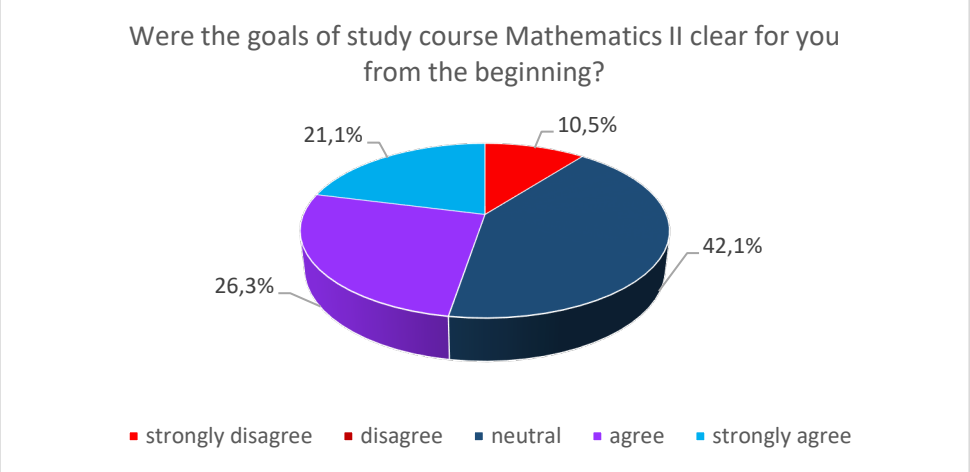


Figure 3.3.2. Students' evaluation of the course Mathematics II in general

From the surveys of students it can be concluded that in order to better master the subject matter they need explanations, consultations and detailed examples of problem solving. Teachers admit that they have to provide a lot of explanations, and students appreciated consultations with the lecturer. Questionnaire about learning habits reveals that 37.3% of students rated consultations as great.

The same opinion are shared by students who experienced online learning. 68.4% of them assessed online consultations as good and as very good (see figure 2.5.1). In the same questionnaire students demonstrated how important for them is the detailed explanation of problems (see figure 2.5.2). It follows that more attention should be paid to those students who have not gained a full understanding of the subject matter in lessons.

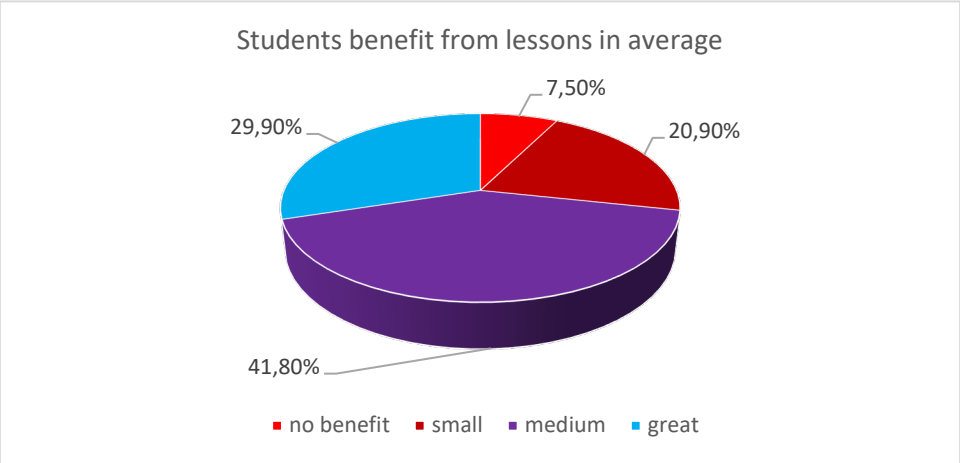


Figure 3.3.3. Students' assessment of their benefit from theoretical lessons on average

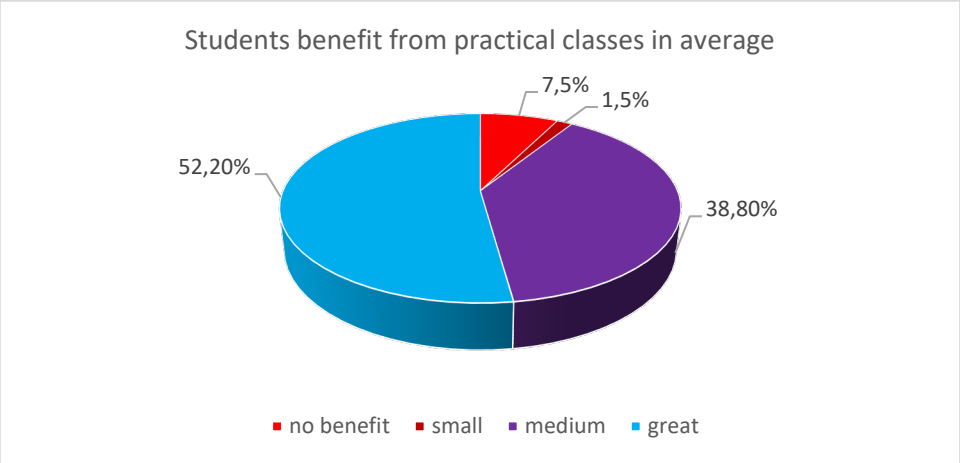


Figure 3.3.4. Students' assessment of their benefit from mathematics practical classes on average

When speaking about the students' learning activities, teachers were critical. They pointed out that students do not work regularly and did not complete the duties on time (from teachers' questionnaire). From students' survey one can see that they spent much time for learning (see figure 2.3.4.1). And they learn through a variety of opportunities: from textbooks, from notes, solving additional exercises, using computers and searching for useful information in the internet (see figure 3.5).

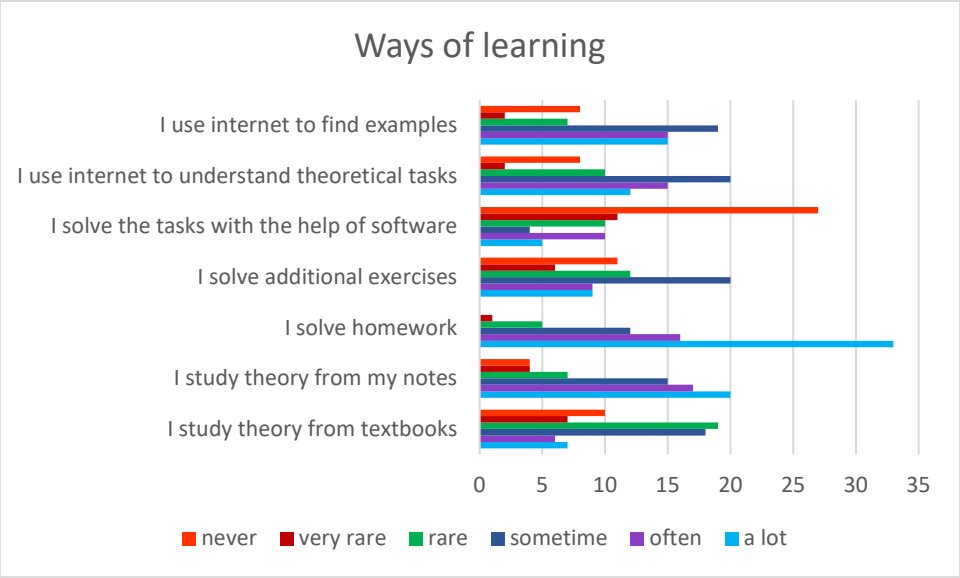


Figure 3.3.5. The ways of students' individual learning

4 Conclusions

The survey of teachers reveals that teachers work with traditional methods, rarely use IT and internet materials in their lessons. They have the misconception that students can be interested in the subject of mathematics with a static performance using a whiteboard, marker, and sometimes putting up presentations. The work in the classes should be organized in a more active way involving students in various activities. It is necessary to develop modern didactic tools for effective teaching applying IT. Teaching methods must be suitable for students with different levels of mathematics knowledge. In response to the changing world, it is important to develop the structure and methods of online lessons.

Polish Naval Academy

Abstract

The study was based on questionnaires given to the teachers (n=3, two men, one woman) and students (n = 52) of the Faculty of Mechanical-Electrical Engineering of PNA during the summer semester, 2019/2020 academic year. The main goal of the study was to understand students and teachers view of the methods and tools which are used in teaching math in classroom. We are also interested in recognizing the level of teachers and students satisfaction during the process of teaching and learning.

The survey dedicated to the maths teachers included questions about their point of view on methods and tools of teaching used during lectures and exercises, students activity, engagement and their mentation in process of learning.

The student survey was aimed to identify their mathematical background and show their awareness of the importance of mathematical skills in further study and future job.

The responses inform that the methods of teaching math are not excessively effective. On the other side teachers use traditional -but still hold good - methods which are not much attractive for nowadays students. Generally students are not interested in learning mathematics. They do not want to understand that mathematics is not only theory, formulas, theorem etc. but also the ability to solve real life problems. Mostly, their attitude to it is caused by the system of education in primary and secondary school. Half of the students have low motivation level to work hard, so they do not have the adequate mathematical knowledge for realizing that math is necessary for studying technical sciences.

1. Introduction

The unsatisfactory grades obtained by students on mathematical exams is mostly attributed to their mathematical background.

The carried our surveys and the conclusions arising from them can be helpful to develop new or more effective mathematical methods and tools in encouraging maritime universities students and extend their interest in learning maths.

Needs for the program phase.

The courses based on mathematics are mostly included in the first three semesters of the bachelor degree and in the first semester of the master degree at the Faculty of Mechanical-Electrical Engineering at Polish Naval Academy in Gdynia, Poland. These courses require not only students activity in the classroom but also the exhaustive knowledge of math which they should gain in high school. The system of education in Poland provide for two kinds of mature exams after high school: the so-called basic level of mathematical exam -mandatory for all high school students (the problems are rather open-and-shut) and the extended level - dedicated to young people who are going to choose the technical studies. There is quite a big difference in mentioned exams. The second one requires almost perfect skill in math problem solving. In case of both exam one has to obtain 30% of the correct answers to

pass. To be enrolled to the FM-EE the candidates have to present the results of the extended level of math exam.

Tables 1.-3. present the results of students successes of passing the final exams from mathematics and the related subjects, obtained in the last academic year (2018-2019), are analysed. The number of enrolled students and their achievements in passing the exams of all math courses and the related subjects.

Table 4.1. Number and percentage of students who passed the final exam in the mathematical courses and related subjects in the Faculty of Mechanical-Electrical Engineering at PNA, Gdynia

Subject	Mathematics I sem. 1.			Mathematics II sem2.			Mathematics III sem.3		
Undergraduate studies	**Enrolled students**	**Pass (C)**	**Pass (%)**	**Enrolled students**	**Pass (C)**	**Pass (%)**	**Enrolled students**	**Pass (C)**	**Pass (%)**
Mechatronics	**24**	**17**	**71%**	**16**	**8**	**50%**	**19**	**14**	**74%**
re-enrolled	7	4	**57%**	4	4	**100%**	5	4	**80%**
first time	17	17		8	8		14	14	
Automatic Control and Robotics	**19**	**10**	**53%**	**25**	**16**	**64%**	**14**	**11**	**79%**
re-enrolled	9	5	**56%**	9	2	**22%**	3	1	**33%**
first time	10	10		16	16		11	11	
Mechanical Engineering	**35**	**9**	**26%**	**19**	**13**	**68%**	**14**	**14**	**100%**
re-enrolled	26	10	**38%**	6	1	**17%**			
first time	9	9		13	13		14	14	**100%**
Grand Total	**78**	**36**	**50%**	**60**	**37**	**54%**	**47**	**39**	**78%**

Table 4.2. Number and percentage of students who passed the final exam in the related subjects in the Faculty of Mechanical-Electrical Engineering at PNA, Gdynia

Subject	Decision support systems sem.5.			Fundamentals of systems reliability sem. 4.			Dynamic systems sem.5.		
Undergraduate studies	**Enrolled students**	**Pas (C)**	**Pass (%)**	**Enrolled students**	**Pass (C)**	**Pass (%)**	**Enrolled students**	**Pass (C)**	**Pass (%)**
Mechatronics	6	6	**100%**	14	14	**100%**	6	6	**100%**
re-enrolled									
first time	6	6	**100%**	14	14	**100%**	6	6	**100%**
Automatic Control and Robotics				11	11	**100%**			
re-enrolled									
first time				11	11	**100%**			
Mechanical Engineering									
re-enrolled									
first time									
Grand Total	**6**	**6**	**100%**	**25**	**25**	**100%**	**6**	**6**	**100%**

Table 4.3. Number and percentage of students who passed the final exam in the related subjects in the Faculty of Mechanical-Electrical Engineering at PNA, Gdynia.

Subject	Applied mathematics		
Master studies	**Enrolled students**	**Pass (C)**	**Pass (%)**
Mechatronics	**15**	**9**	**60%**
re-enrolled	3		

first time	12	12	**100%**
Mechanical Engineering	**7**	**7**	**100%**
re-enrolled			
first time	7	7	**100%**
Grand Total	**22**	**16**	**90%**

During the last academic year, the percentage of students that successfully passed Mathematics I was 50% of the total number of enrolled students, Mathematics II was almost the same while after third semester- Mathematics III- the percentage of students that passed the final exams was close to 80% (78%). On higher semesters: fourth and fifth- all students successfully passed their exams of the subjects related to maths: Decision Support Systems , Dynamic Systems – both on 5th semesters, Fundamentals of Systems Reliability- sem. 4. Students were successful in the exams in those subject where the pass rate is 100%.

Those subjects are strictly based on the knowledge of mathematics they gained during first three semesters.

Table 4.4. Number and percentage of students who dropped from the study and failed the mathematical courses

Year: 2018./2019.		**Mathematics I**		**Mathematics II**		**Non pass (C)**	**Non pass (%)**
Undergraduate studies	**Dropout rate from the study**	**Non Pass (C)**	**Non Pass (%)**	**Non Pass (C)**	**Non Pass (%)**		
Mechatronics	**14**	**6**	**43%**	**4**	**29%**	**10**	**72%**
re-enrolled	1			2			
Automatic Control and Robotics	**10**	**2**	**20%**	**2**	**20%**	**4**	**40%**
re-enrolled	1			2			

Mechanical Engineering	**17**	**7**	**41%**	**4**	**24%**	**11**	**65%**
re-enrolled	0			0			
Grand Total	**41**	**15**	**37%**	**10**	**24%**	**25**	**61%**

Last academic year 41 students dropped from their study. Within this number of dropped students, 15 of them did not pass Mathematics I (37%) and 11 of them did not passed Mathematics II (27%). Summarizing in academic year 2018/2019, out of 41 students dropped out from study, 25 did not passed mathematics (they were removed from the list of students of the Faculty of Mechanical-Electrical Engineering due to failing mathematics exams).

2. Report of teacher and student surveys – quantitative analysis

The results presented in this report are based on surveys carried out on the teachers and students participated in teaching and learning process in few of courses (Mathematics I, Mathematics II, Mathematics III, Decision Support Systems, Fundamentals of Systems Reliability, Dynamic Systems and Applied Mathematics) offered in bachelor study and master study programmes on at the Faculty of Mechanical-Electrical Engineering at Polish Naval Academy In Gdynia. Two questionnaires were designed: a teacher questionnaire and a student questionnaire. It is necessary to add that in previous academic year there were three fields of study offered for students: Mechanical Engineering, Mechatronics and Automatic Control and Robotics. Tables 1.-4. relate to students of those three fields. In the current academic year the Faculty offers also fourth course of study, namely Computer Science. In previous years this course was conducted at the Faculty of Navigation and Naval Weapons, so also the students of IT took part in the student questionnaire.

The teacher questionnaire with 35 items covered tools and method applied by math lectures and exercises in the classroom or for delivering materials and communication with students.

The student questionnaire with 40 items covered issues such as teaching methods and tools used by their lectures and assistants, available learning tools and aids as well as their satisfaction with efficiency and effectiveness of the teaching process.

This research aimed to identify the main factors of students problems in passing maths exams via teachers' and students' review of the teaching methods, tools and gathering their suggestions how to improve the situation which is common for many universities in many countries.

2.1. Target Group.

Three mathematics teachers from the Polish Naval Academy in Gdynia, Faculty of Mechanical-Electrical Engineering were invited to take part in our survey. There were 2 responds from 2 male teachers and 1 female teacher, two with scientific-teaching position and one with a teaching position. Their professional experience as mathematics teachers

ranged more than 15 years. They are very experienced teachers well valuated by students in annual student questionnaires.

The second group included students from Polish Naval Academy in Gdynia, Faculty of Mechanical-Electrical Engineering. They were asked to fill the online questionnaire, prepared on the English language, anonymously and voluntary. 52 academy students at the Polish Naval Academy in Gdynia, Faculty of Mechanical-Electrical Engineering participated in the study. The sample consisted of 46 males and 6 females with a mean age of 22 years old. There were some differences between participating studies in numbers of participating men and women. 88,5% of all participants are male students. The main representation of female students is in Mechatronics and Automatic Control and Robotics studies. Four participants (4,77%) are foreign students from Kuwait. Participants are mostly first-year students (25 students), then second-year (13 students) and from third-year of study (14 students).

Table 4.5. Sex of respondents

Students	**No**	**Students**	**No**
FULL_TIME	**50**	*PART_TIME*	*2*
Female	6	Female	0
Male	44	Male	2

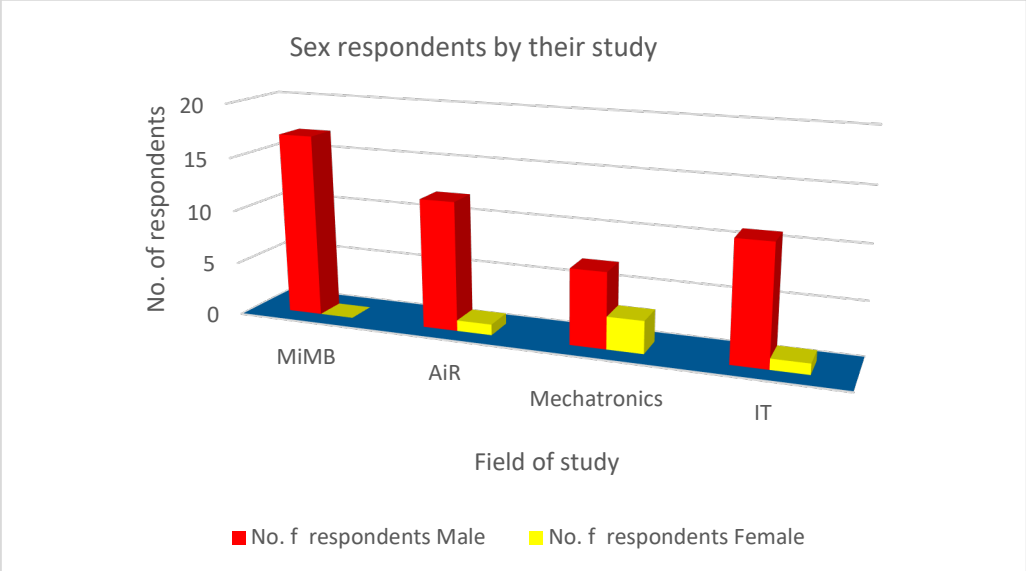


Figure 4.1. Sex respondence by their study

2.2. Student background.

Generally students consider their mathematical background as better than their grades from the high school shows (Figures 2.-3.) The majority of all students (39,2%) rated their prior mathematical knowledge as sufficient, slightly fewer (37,3%) as good, 15,7% of them as very good and 7,8% as poor. No one rated their prior knowledge as excellent and insufficient-see Figure 2. (Based on questions 10 - 11 of the questionnaire).

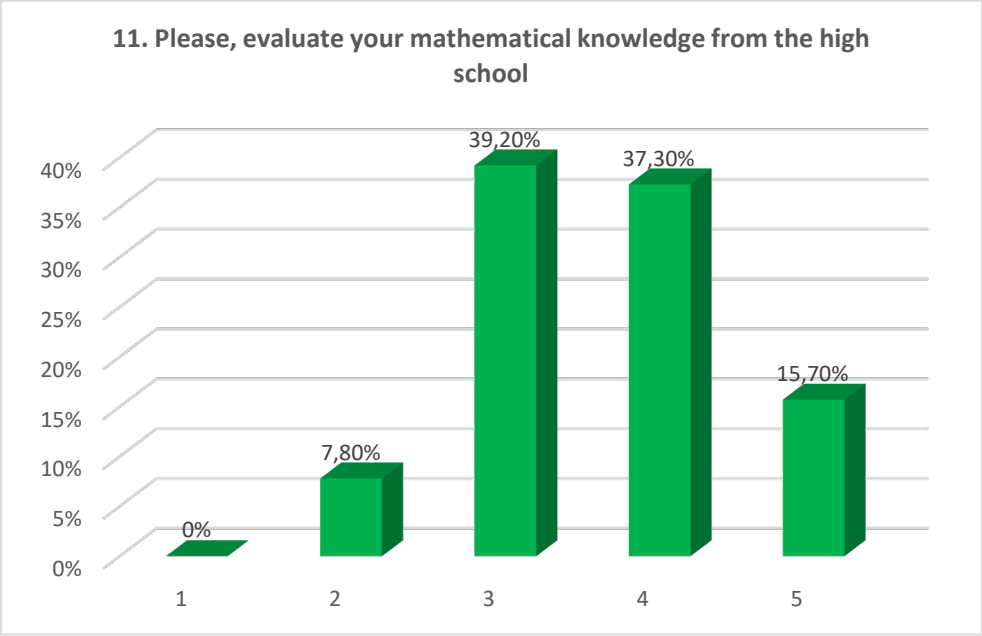
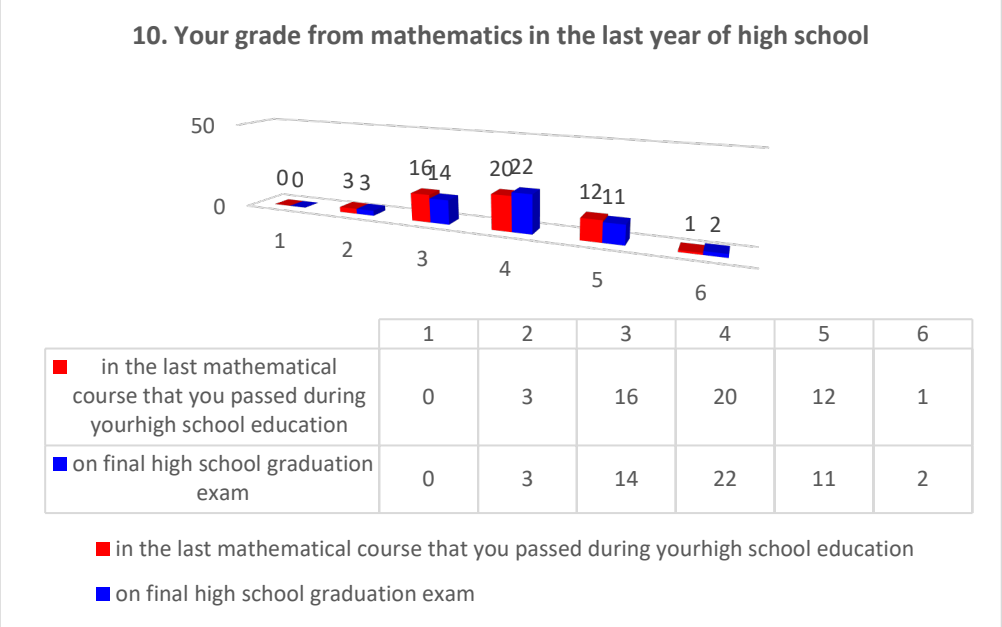


Figure 4.2. Mathematical knowledge from the high school rated by students.



	1	2	3	4	5	6
in the last mathematical course that you passed during yourhigh school education	0	3	16	20	12	1
on final high school graduation exam	0	3	14	22	11	2

Figure 4.3. Students' grades from mathematics in the last year of high school

3. Report of teacher and student surveys – quality analysis

3.1. Tool review

SIGN, LITERATURE, EXAMS.

Teachers were asked about the tools how they inform students about the goals, learning outcomes, grading criteria and evaluation methods. The following table presents the results.

Orally in the introductory lecture	In writing form	Orally in the introductory lecture and in writing form	As guideline outlined on the Faculty's website
2		**1**	

From the other hand, students were asked to indicate their agreement that the learning outcomes and assessment criteria are clearly defined (from 1- Strongly Disagree to 5 - Strongly Agree). Their average grades are respectively 3.68 and 3,72 which means that they are rather satisfied with defined learning outcomes and assessment criteria.

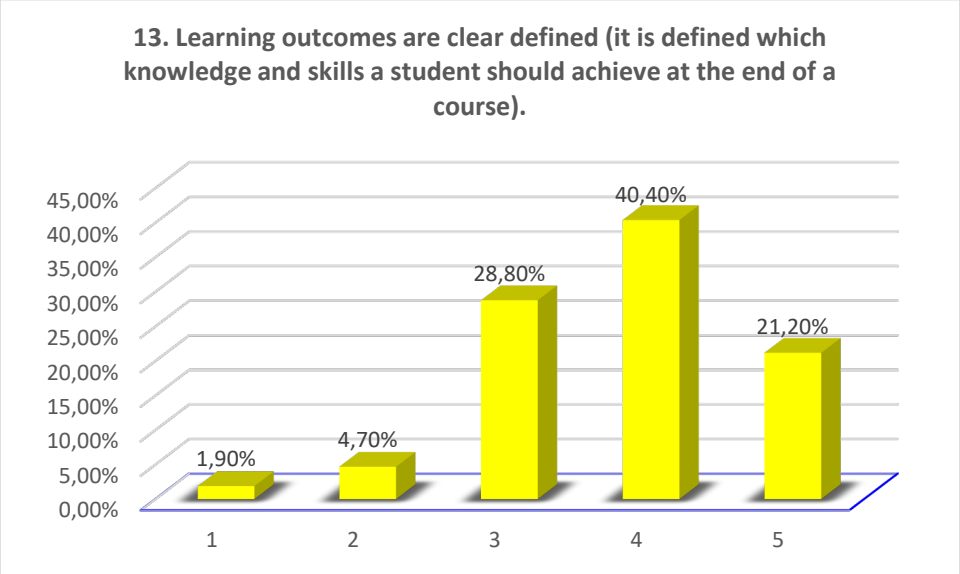


Figure 4.4. Learning outcomes are clear defined- students responces.

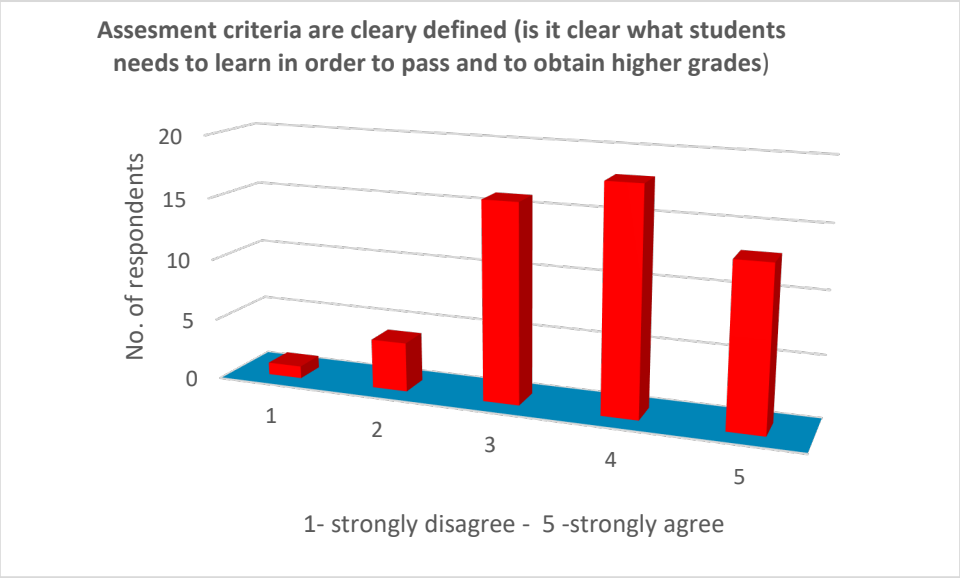


Figure 4.5.

All teachers recommend students teaching materials published on the Internet or e-learning system as literature.

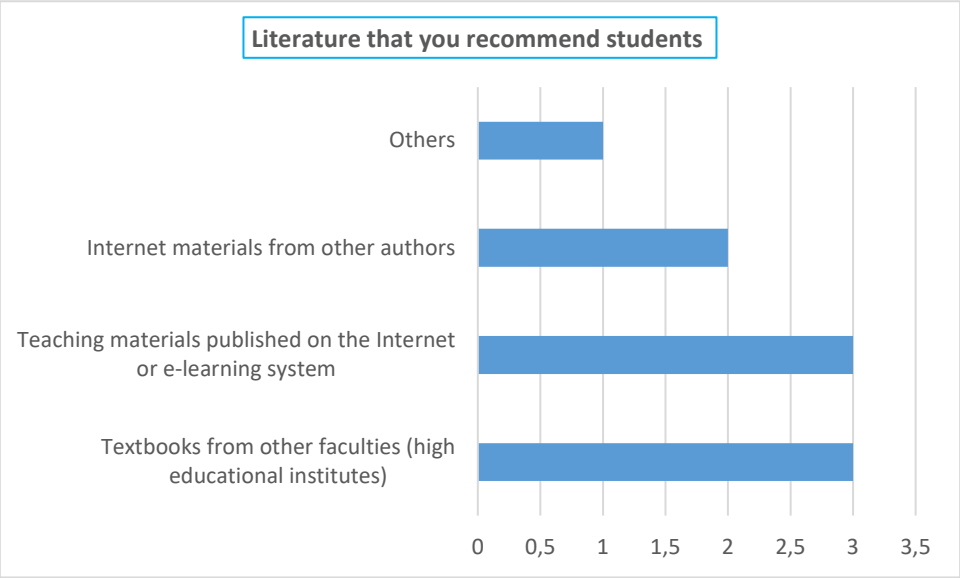


Figure 4.6.

Students were asked about their satisfaction with availability of literature and its appropriateness. Most of the students (55%) are satisfied with the availability of literature while only 12% are not satisfied. About 39% of students find literature appropriate and useful for exam/midterm preparing. About 29% of them have the opposite opinion. The average grade for literature availability is 3.73 and for literature appropriateness is 3.12.

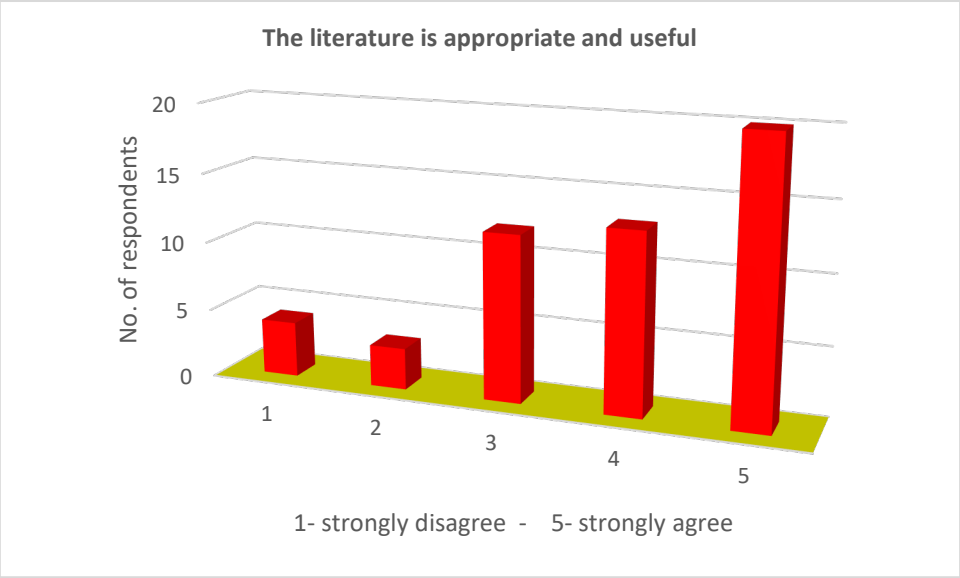


Figure 4.7. Distribution of students' rating on appropriation of the literature

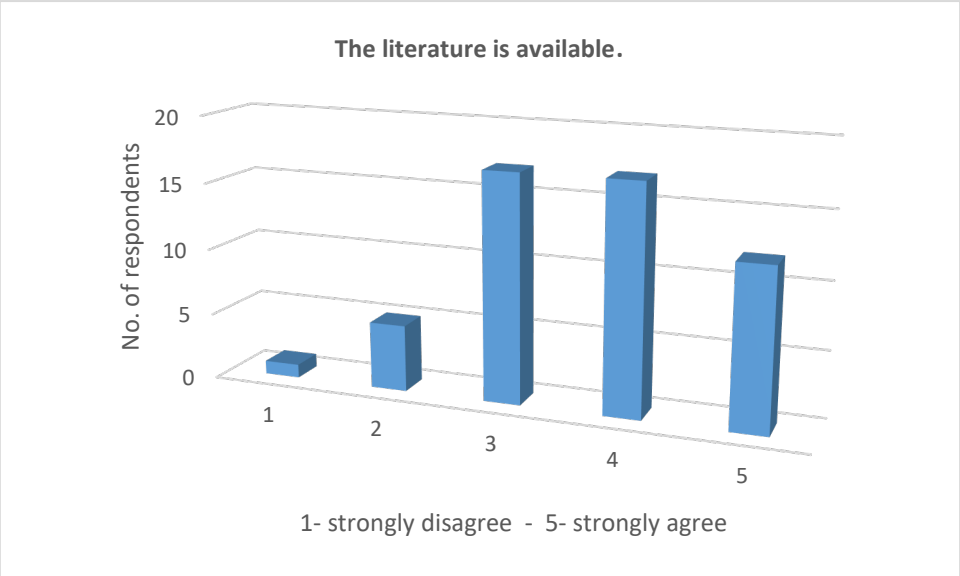


Figure 4.8. Distribution of students' rating on availability of the literature.

TEACHING, LEARNING AND COMMUNICATION TOOLS.

The first point which the survey tried to clarify was the general use of IT and whether it is used for teaching and communication with students. In that respect, the teachers were asked what type of IT they use in the communication process. As expected, eduPlatform - the e-learning platform ongoing at PNA and e-mail - have dominated the scene, with 100% of the teachers using them for distribution added learning materials (files, presentations, student's tasks, problems to solve etc.) (Figure 9).

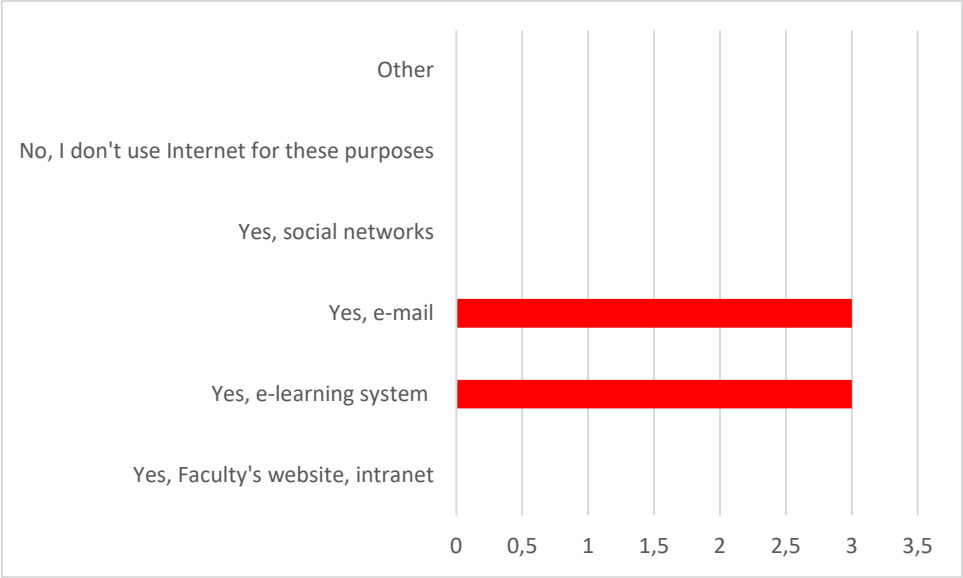
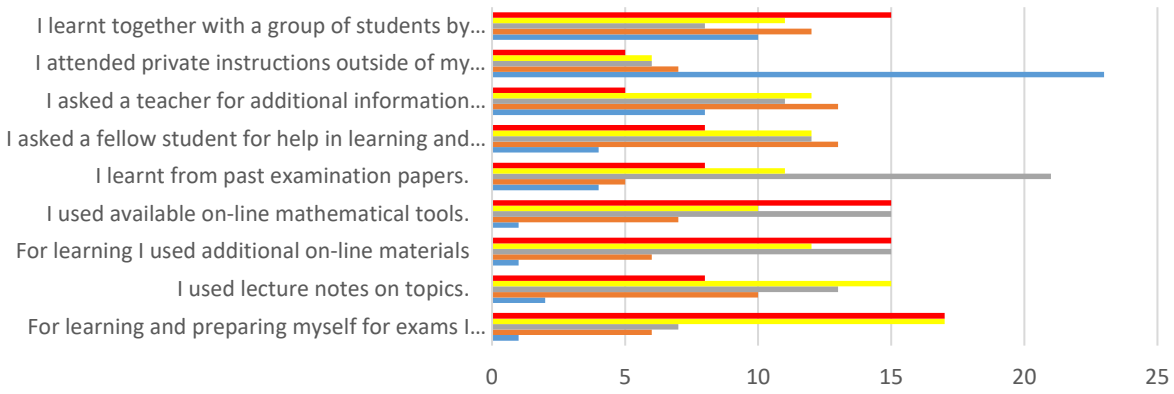


Figure 4.9. Tools for distribution added learning materials and communication with students

Information technology is rather useful in teaching process. Students always (15,7%) or often (29,4%) learn lecture notes on topics (15,7%) and always (15,7%) or often (19,6%) learn from past exams. Additional on-line learning materials are always or often used by 52,9% of students. Similarly , mathematical tools which are available on–line are used by 49% . Additionally, 37,3% of students always or often ask a fellow student for help in learning and only 17,6% of them always or often attend individual instructions outside of the Faculty. A significant percentage of students (31,4%) ask the teachers for help in learning (Figure 10.) Teacher use e-mails to communicate with students but no teacher use social networks for communication. Probably this is the reason why students never or extremely rarely use those tools for learning. It seems to be strange as lots of students can use free WIFI and what is more they are very familiar with social media.



	For learning and preparing myself for exams I mostly used my own classroom notes.	I used lecture notes on topics.	For learning I used additional on-line materials	I used available on-line mathematical tools.	I learnt from past examination papers.	I asked a fellow student for help in learning and explanation of mathematical contents.	I asked a teacher for additional information about mathematical matter	I attended private instructions outside of my Faculty.	I learnt together with a group of students by social networks.
always	17	8	15	15	8	8	5	5	15
often	17	15	12	10	11	12	12	6	11
sometimes	7	13	15	15	21	12	11	6	8
rarely	6	10	6	7	5	13	13	7	12
never	1	2	1	1	4	4	8	23	10

Figure 4.10. Learning support that students received

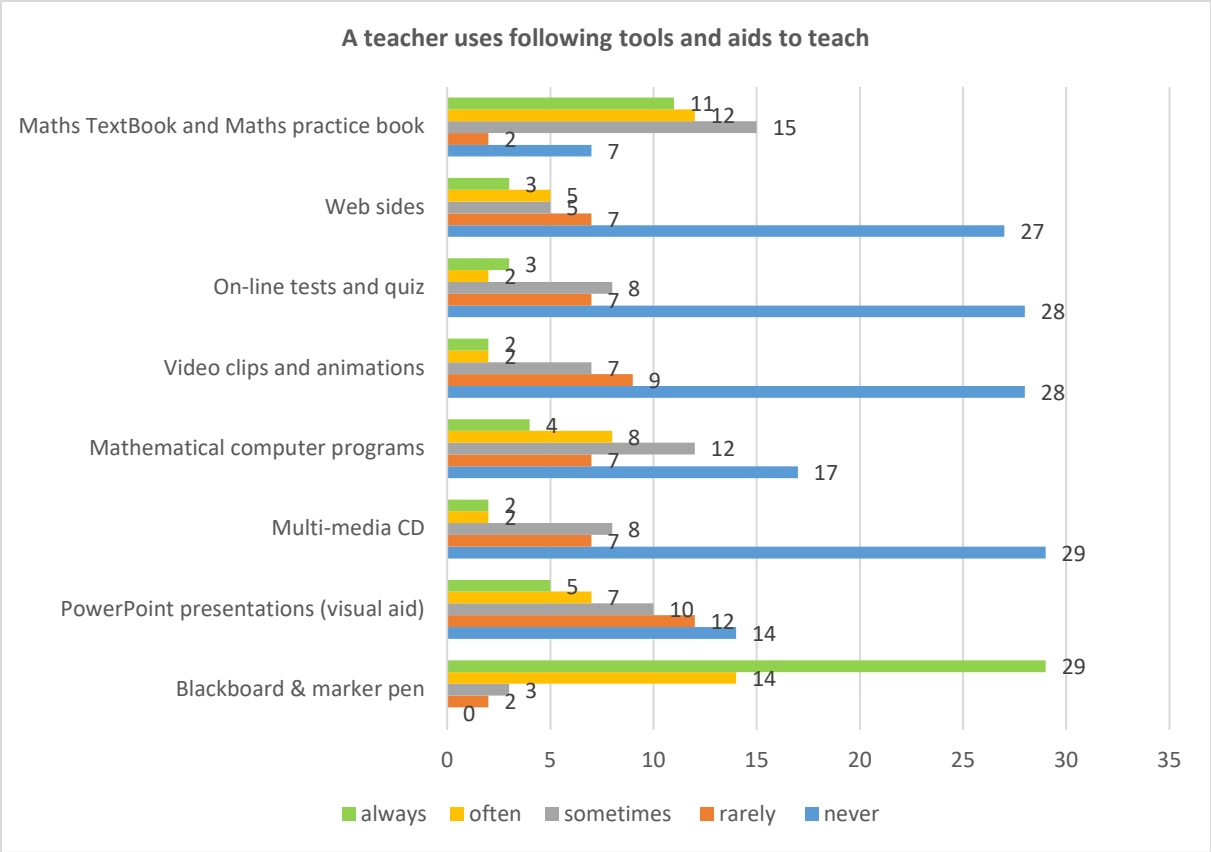


Figure 4.11. Tools which the teachers use in teaching process.

Students were also asked about the types of tools the teachers usually employ for teaching. As expected, blackboard/whiteboard and marker pen is dominated - Figure 11. A very low percentage of answers indicated usage of various IT tools confirms that majority of teachers use blackboard/whiteboard and marker pen in teaching process. Teachers rather rarely

(4% -9,6%) use IT tools: web sides, on-line quiz and test, videoclips, mathematical computer programs, power point.

Lots of students confirmed that " teachers always have been helpful and they were able to help if someone did not understand the topic". They admit "the teachers have a lot of knowledge and are able to pass on (to transfer on) it very well. Lecturers are well prepared to give lectures"

Teachers' responses on the item "An exam of your course is organised as" are as follows:

Exclusively as written	Exclusively as oral	Written and oral	Written or oral	Other
3	0	0	0	0

Summarizing

Teachers	Communication with students is mainly by emails and e-learning platform Students can find the course syllabus, teaching plan, assessment plan and teaching materials students can find on the faculty website. For teaching and lesson presentation they prefer to use blackboard or whiteboard and marker pen, together with PowerPoint presentations. There is a very low use of some modern resources, such as interactive quizzes or on-line tests, video clips and animations. It is mostly because of the insufficient number of contact hours of maths.
Students	Students have used posted materials on topics and past exams for learning. They have also used other online materials. Some students have looked for the help from other students or from private instructions outside of the Faculty. They have sometimes exchanged ideas and opinions between themselves using social networks but they certainly preferred contact face to face or mailing communication with the teacher. There has been a very rare use of public computer math applications.

3.2. Need analysis.

Table 6. presents the distribution of responses and descriptive statistics across items that show teacher opinion and satisfaction with the teaching environment. There are five related items and five response options have been used on each the item. Of each item, the choices were from Strongly Disagree to Strongly Agree. Each item indicated a mean very close to 4,0 (3,928) (on a scale of 1 to 5) and average SD for all items is about 0.43.

Table 4.6. Distribution of Responses and Descriptive Statistics across Items

	1 - strongly disagree	2 – disagree	3 - neutral	4 – agree	5 - strongly agree	Mean	SD
10. The space and technical conditions for teaching are appropriate to the teaching needs.	0	0	0	3	0	4,0	0
11. The availability of teaching aids meets the needs of the course.	0	0	1	2	0	3,67	0.43

12. Collaboration with other math teachers is successful.	0	0	0	2	1	4,3	0.47
13. The number of students is well aligned with the available teaching capacity.	0	0	1	1	1	4,0	0,82
14. You have enough time to prepare myself for teaching	0	0	1	2	0	3,67	0.43

From the other side, students mostly confirmed that attending lectures/exercises has contributed to an increasing their knowledge (48%/60,8%) and made easier to prepare them for exams/midterms (51%/64%) - Figure 12.

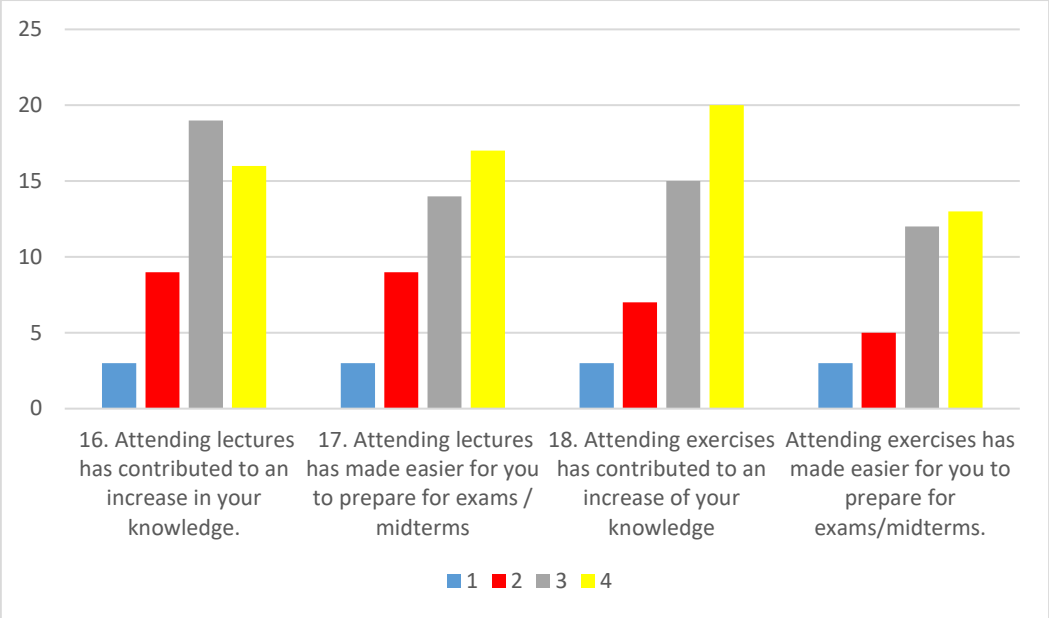


Figure 4.12. Students responses regarding the effectiveness of attending classes.

CLASROOM EXPERIENCES.

Considering teachers responses, they try to explain matters to students as well as possible. From the other side, they use traditional teaching methods, rather don't use interactive contents and not very often connect solving mathematics tasks with problems in real life (Figure 15.) That fact can be the main reason why students have considered teaching methods as insufficient and sometimes uninteresting.

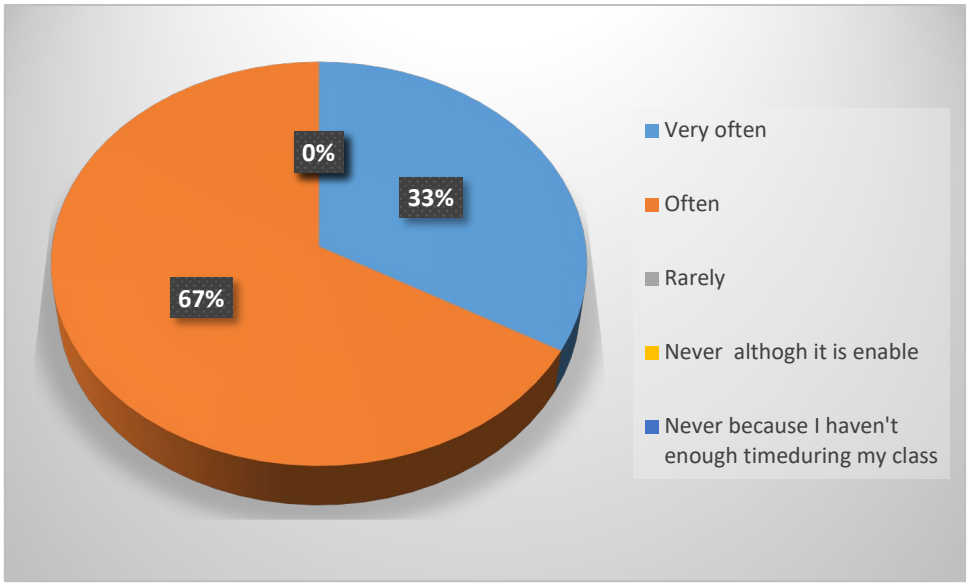


Figure 4.13. Distribution of teachers responses on the item "During your class do you explain a matter again if it is not clear to them?"

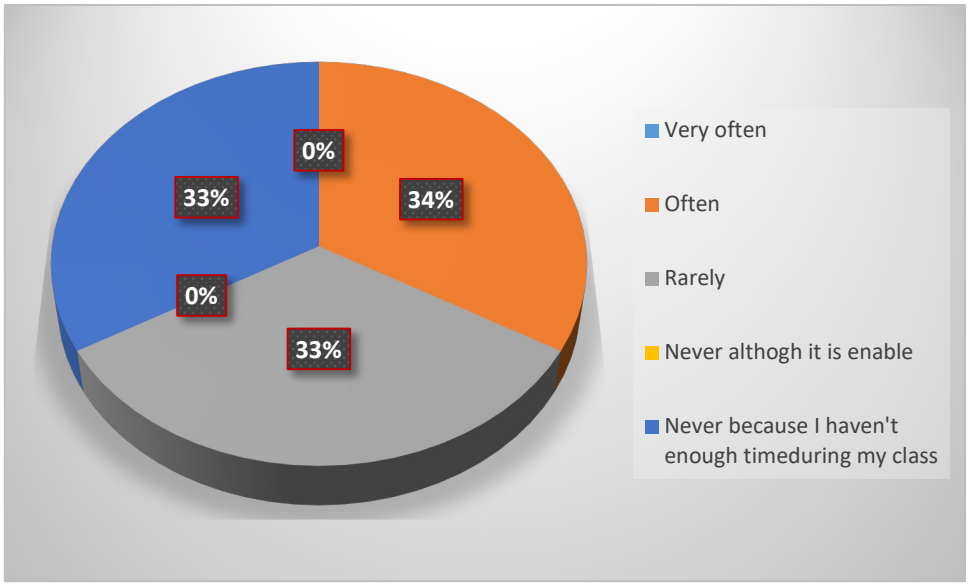


Figure 4.14. Teachers responses on the item" Students work in small groups to come up with a joint solution to a math problem."

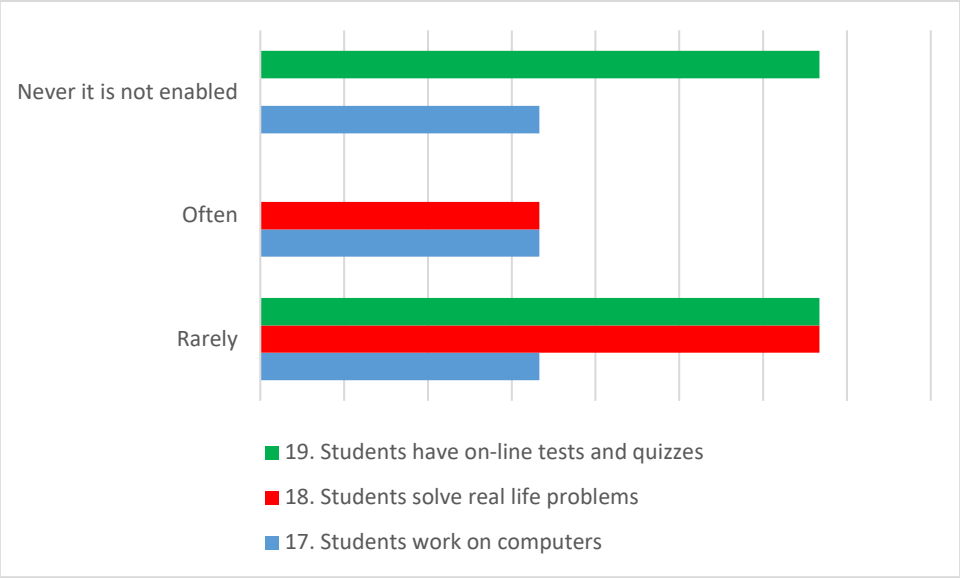


Figure 4.15. Teachers perception of students participation in learning activities

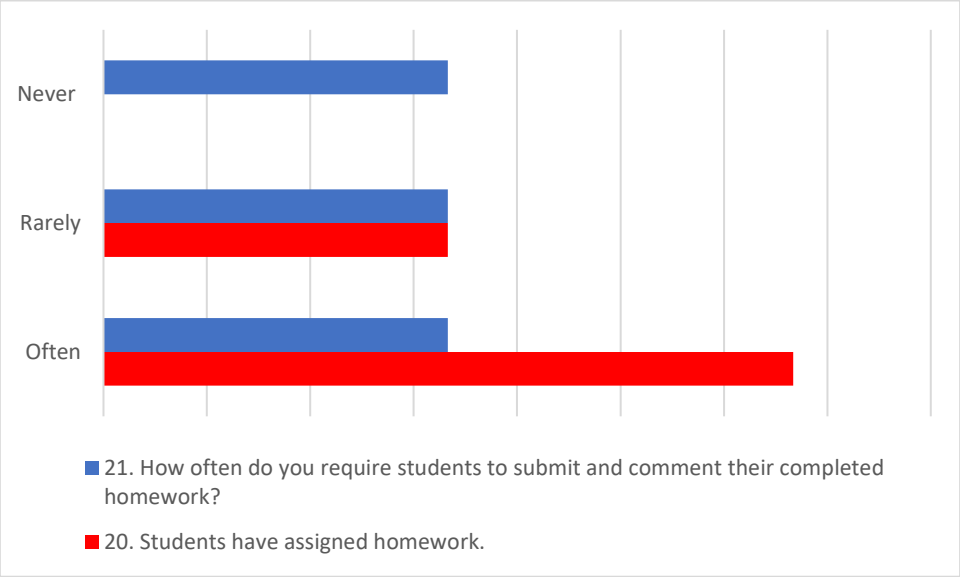


Figure 4.16. Homework activities

Figure 17. presents students opinions about the ways of teaching, their suitability and attractiveness. As it is seen the students perception of it is divided: 51% of students are satisfied and very satisfied with the teaching methods while many as 16% of students rated the methods as absolutely inappropriate and uninteresting.

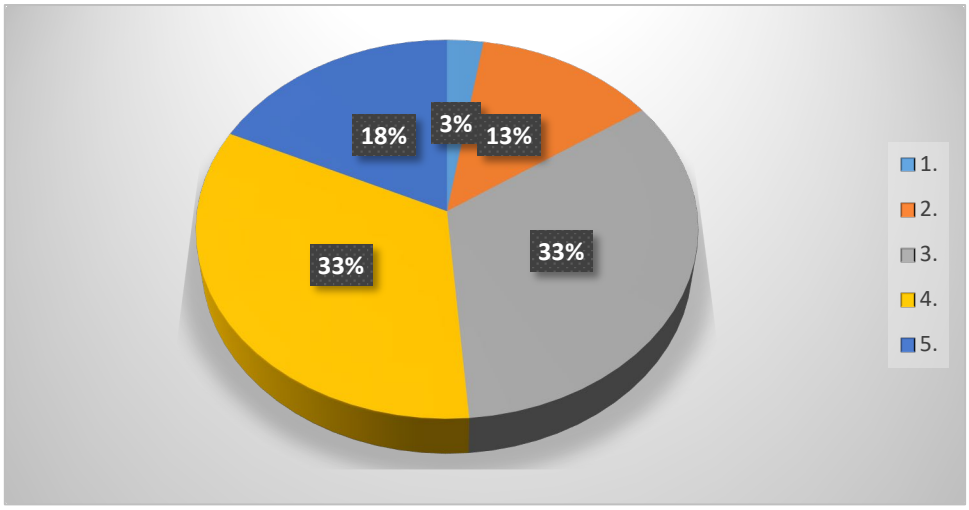
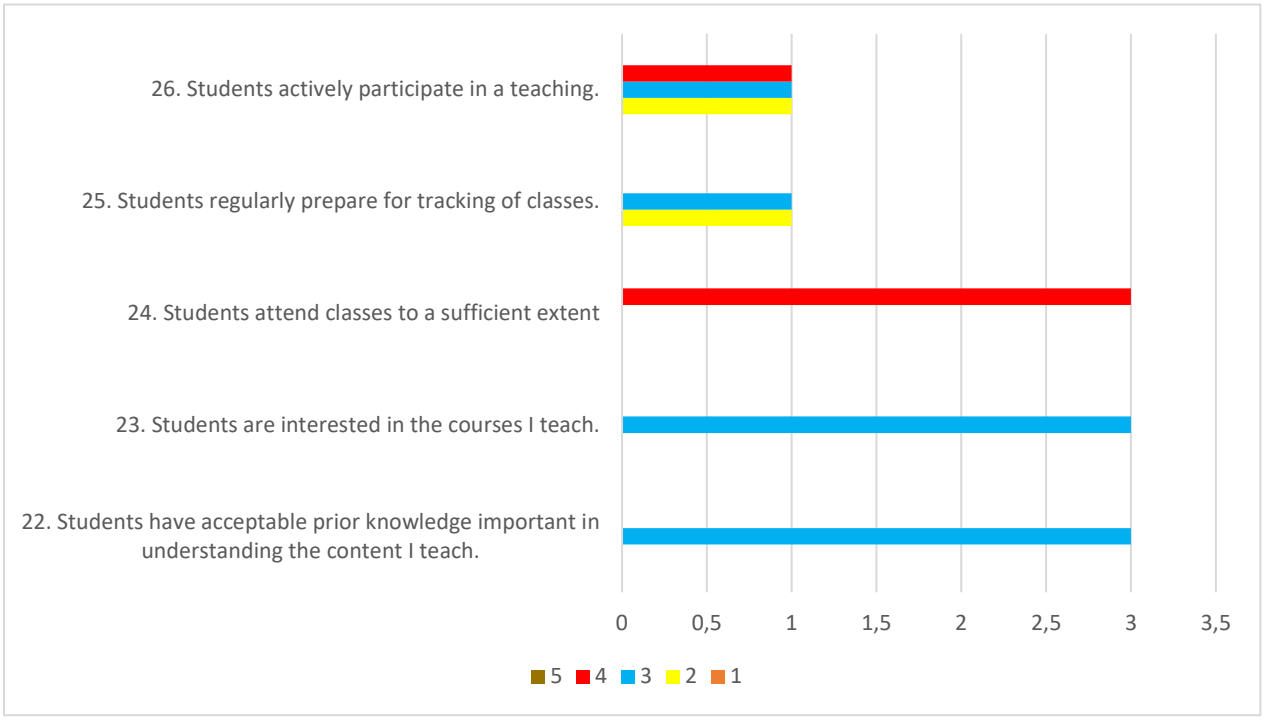


Figure 4.17. Students rate on suitability and attractiveness of teaching methods

TEACHERS ASSESSMENT OF STUDENTS PERFORMANCE AND BEHAVIOUR.

From the teachers perspective (Figure 18.), results revealed a rather average level of students prior knowledge, their interest in the math courses and that they are rarely prepared for tracking classes. Some kind of explanation can be found in students perception of teaching maths (Figure 20). The students have realised the importance of mathematics in their profession. They quite well understand that knowledge gained through mathematical courses will be useful for their future job and in solving real life problems. It is in opposition to their preparing for classes, passing exams, perception of learning and teaching and understanding the vital role of mathematics in the technical studies.



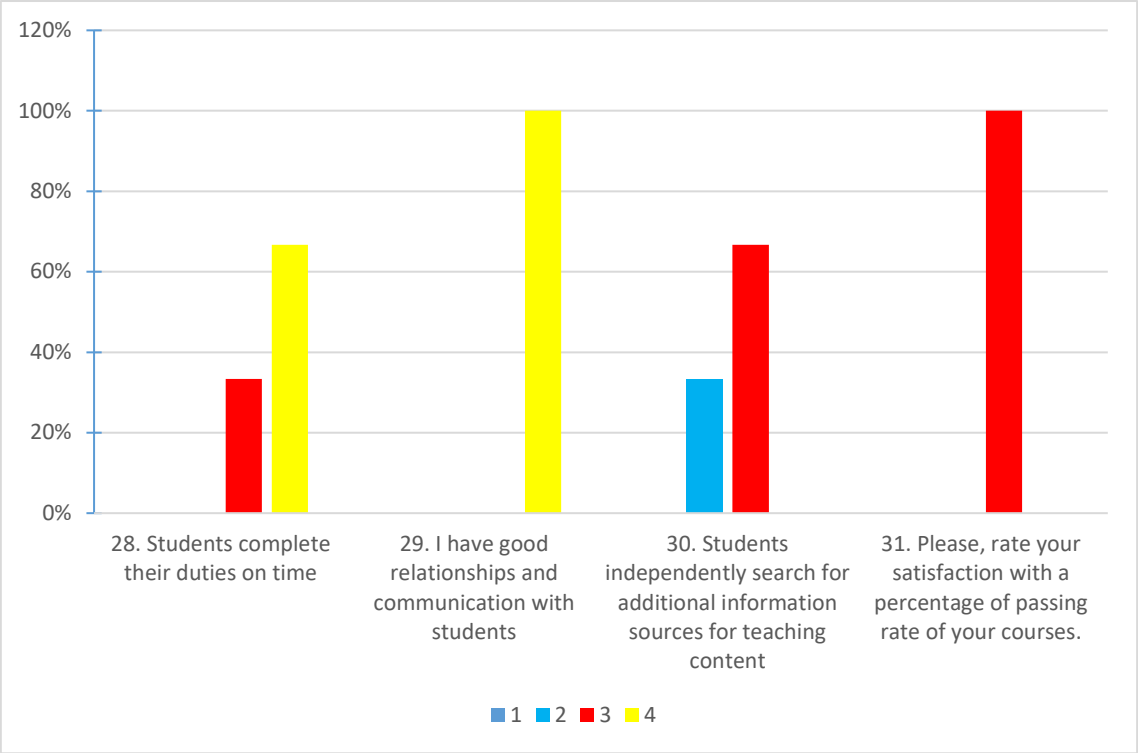


Figure 4.18. Overall teachers satisfaction with students engagement in teaching/learning process.

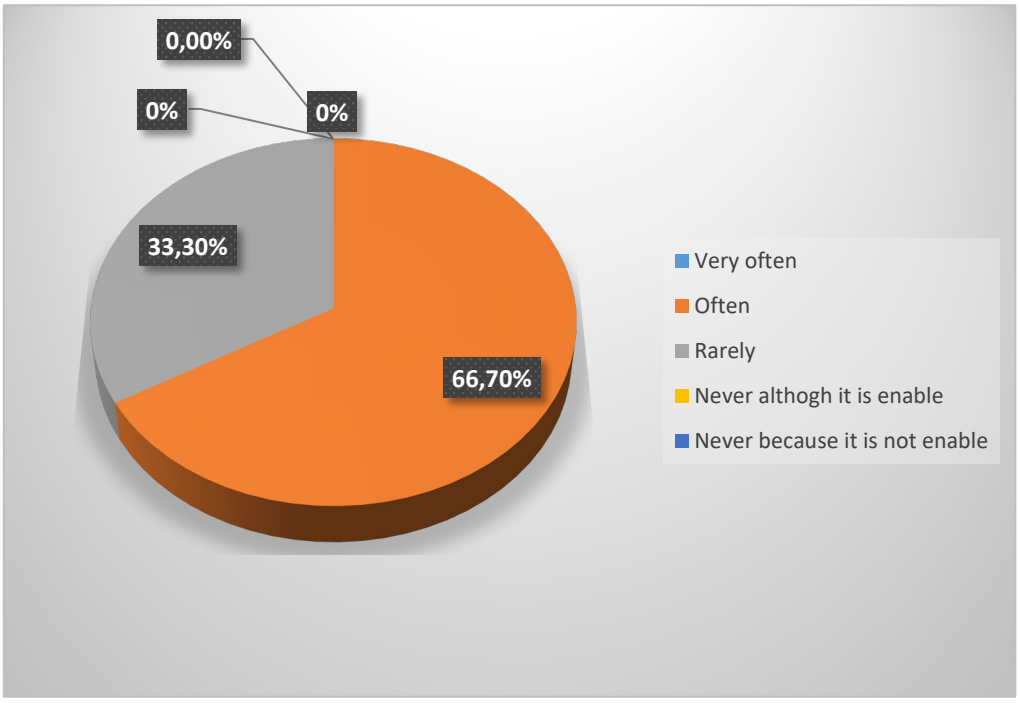


Figure 4.19. Teachers confirmed that students often ask them to explain a matter if it is not clear something

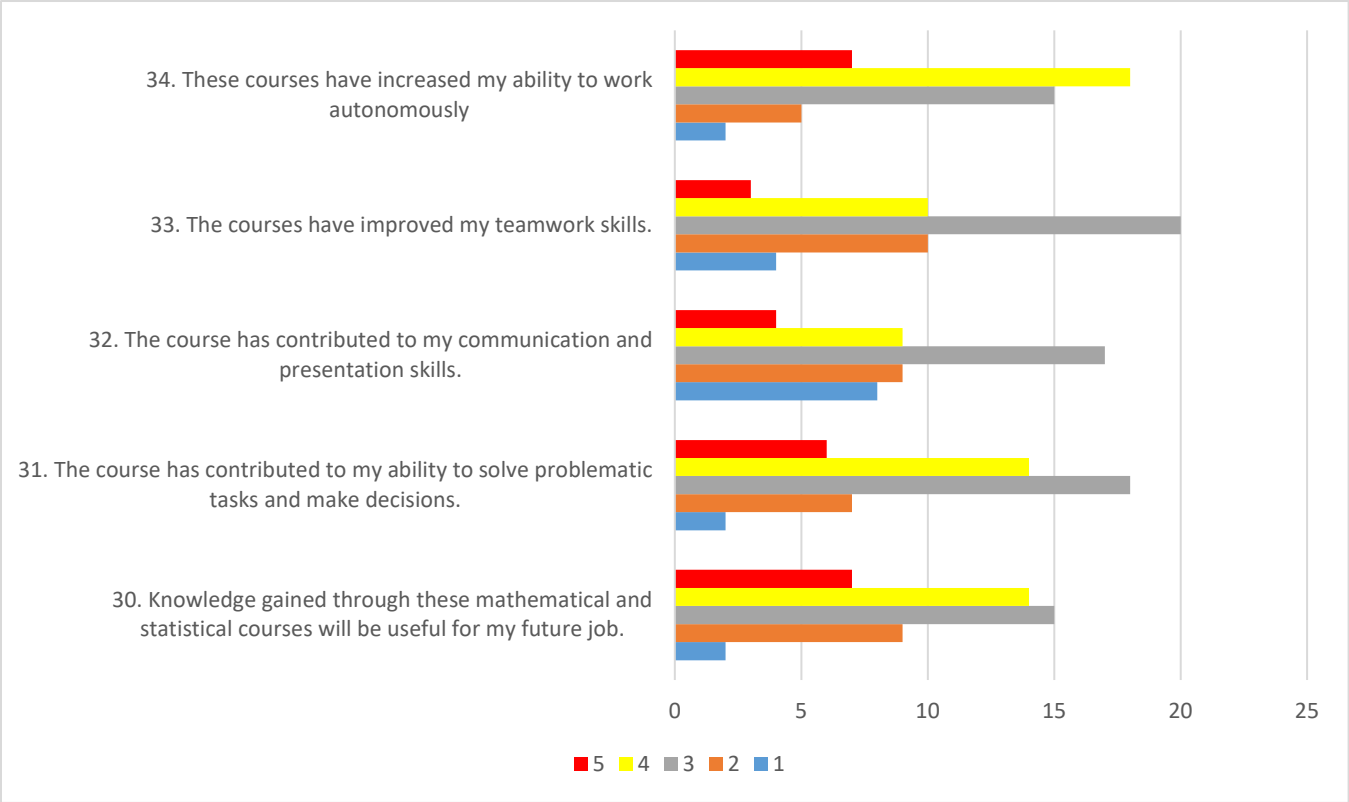


Figure 4.20. Students perception of math importance for their future job and for improving their skills.

From Figure 20. it is seen that the teachers are not satisfied with the success level of passing exams. According to their opinion, there are some reasons for pass rate achieved. They are: lack of student engagement, not sufficient basic knowledge the students have gained in high school, students are not motivated.

To raise the percentage of passing rate of math courses teachers recommended following efforts and activities: better prior knowledge gained in high school, increasing teaching hours for lectures and exercises (at PNA there are 150 hours of mathematics course excluding the relative subjects) or organizing compensatory course of maths before starting the first semester of the study and explain again some topics from high school, setting connections in relation to other technical subjects.

STUDENTS' ASSESSMENT OF TEACHER'S PERFORMANCE.

On the basis on Figures 21. - 23. we can conclude that students have evaluated their teachers as well experienced, prepared for lessons, keeping students focus on lessons. Their opinions and verdicts are just and fair to the teachers both lecturers and assistants.

According to the surveys, there is a little difference in students opinions on lecturers and assistants. Students state that lecturers always (15,7%) or often (47,1%) explain the lesson matter in a clear way. Teaching hours are always (37,3%) or often (31,4%) well prepared and organized.

Less students (35,3%) admit that lecturers always or often link abstract problems with real life.

Only 31,4% students always or often see a variety of methods and teaching tools used to improve lectures. 43,1 % of them think that this happens only sometimes. According to 43% of students, classes are always or often dynamic and lecturers stimulate discussion.

In students' opinion mathematics assistants are always (23,5%) or often (31,4%)

well organized and prepared for every class. They also provide always (21,6%) or often (31,4%) enough worked examples. Only 31,4% (the same percent as in case of lecturers) students always or often see a variety of methods and teaching tools used to improve exercises . 45,1 % of them think that this happens only sometimes. As much as 57% of students (more than in case of lecturers) admit that their mathematics assistants keep classes dynamic by stimulating discussion.

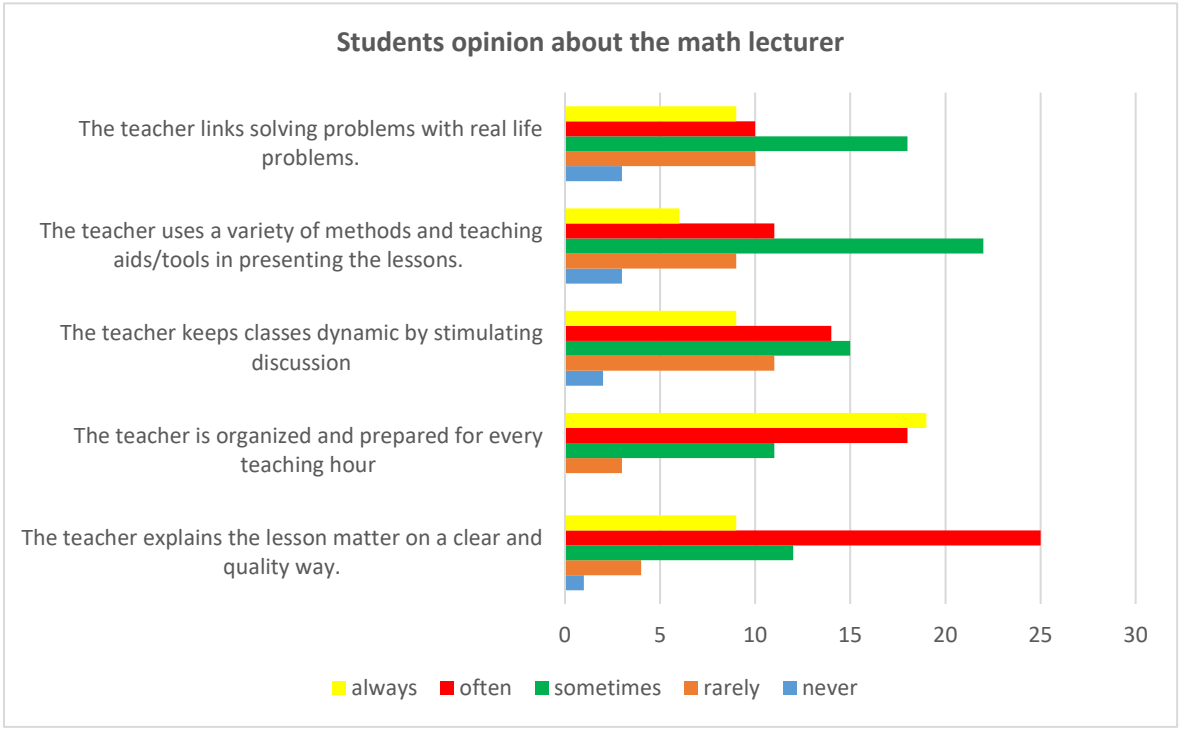


Figure 4.21. My math teacher (lecturer).

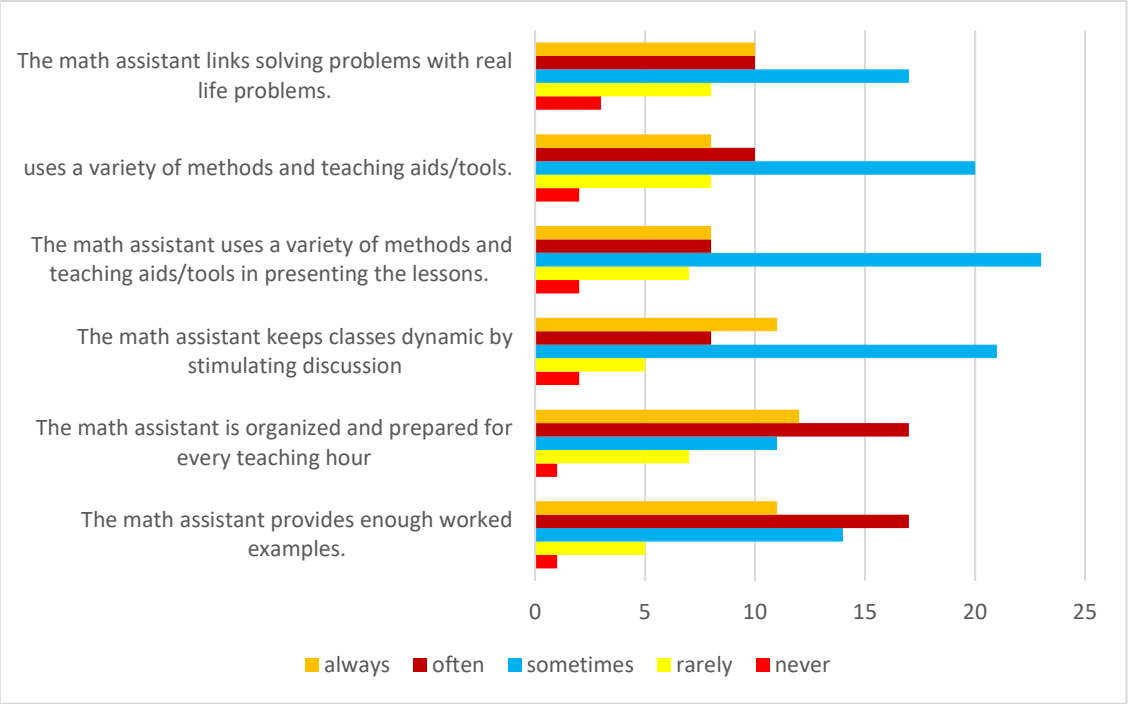


Figure 4.22. My math assistant.

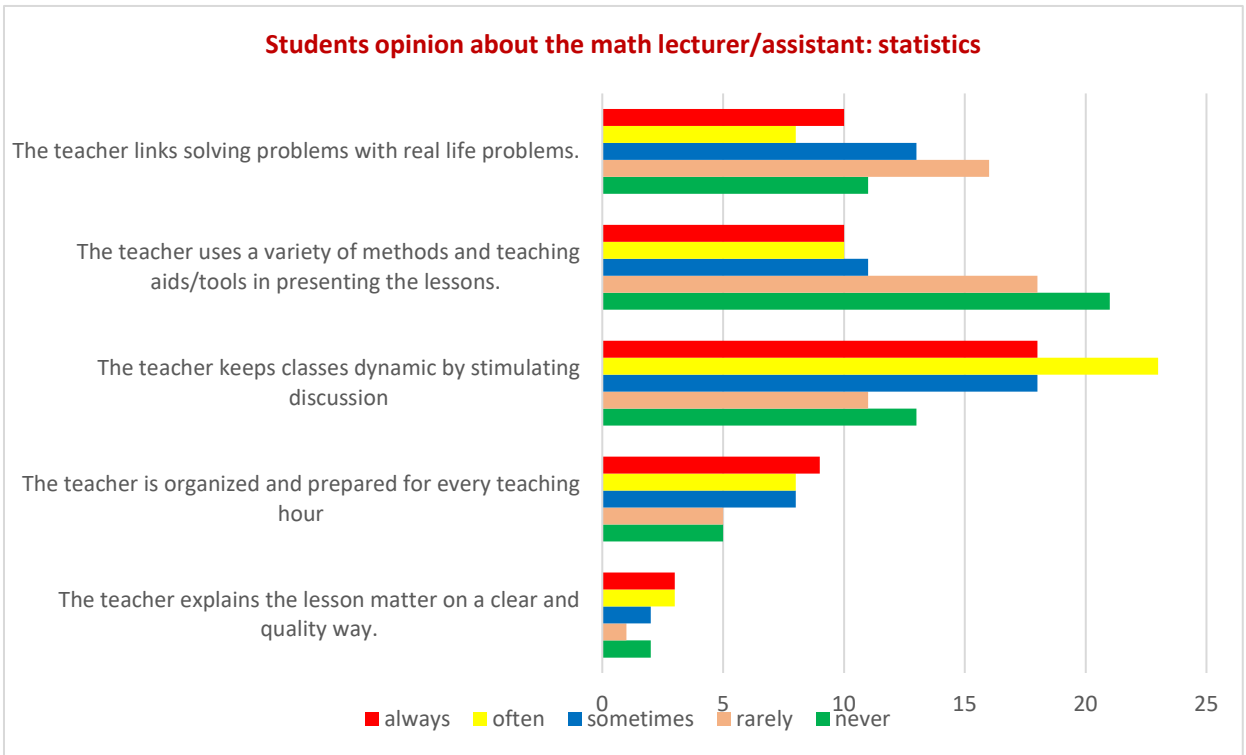


Figure 4.23. Students feeling on math teachers /assistants-statistics

SUMMING UP.

All teachers from the Faculty of mechanical-Electrical Engineering at PNA who participated in the survey assessed their satisfaction with the classes of math realized in the last academic year 2018/2019 as average 100% - Figure 24. They were not particularly pleased but were also not dissatisfied.

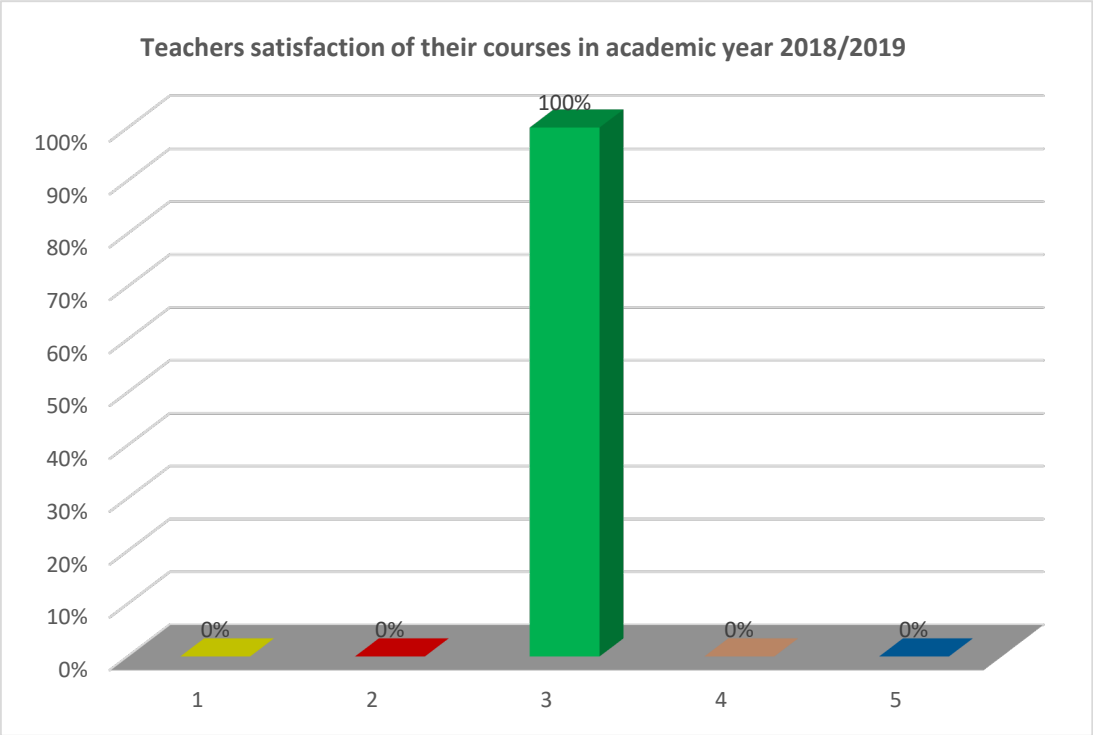


Figure 4.24. Teachers satisfaction of their courses in previous academic year 2018/2019.

Students also shared teachers opinion. They graded math courses as shown on Figures 25. and 26.

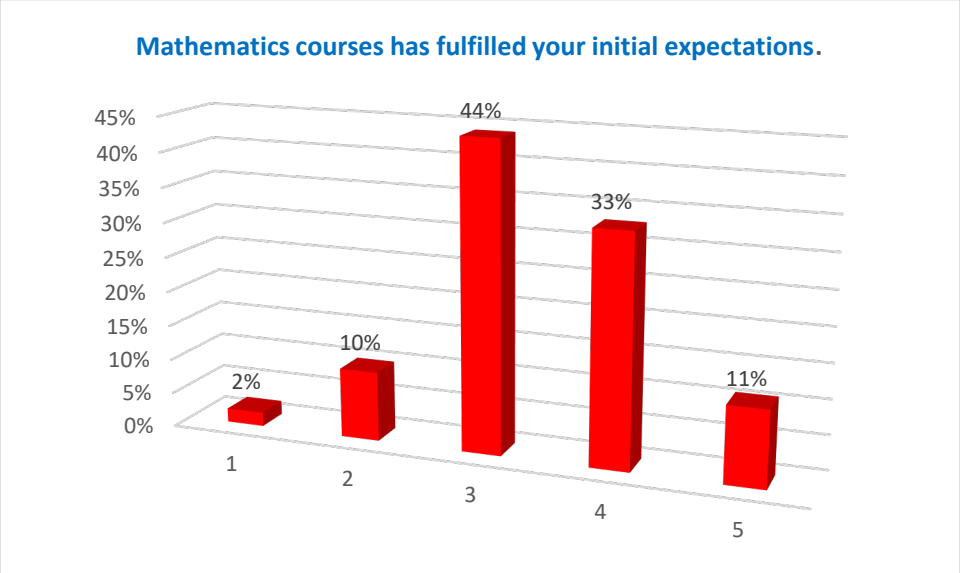


Figure 4.25. Students grade of their satisfaction with Maths.

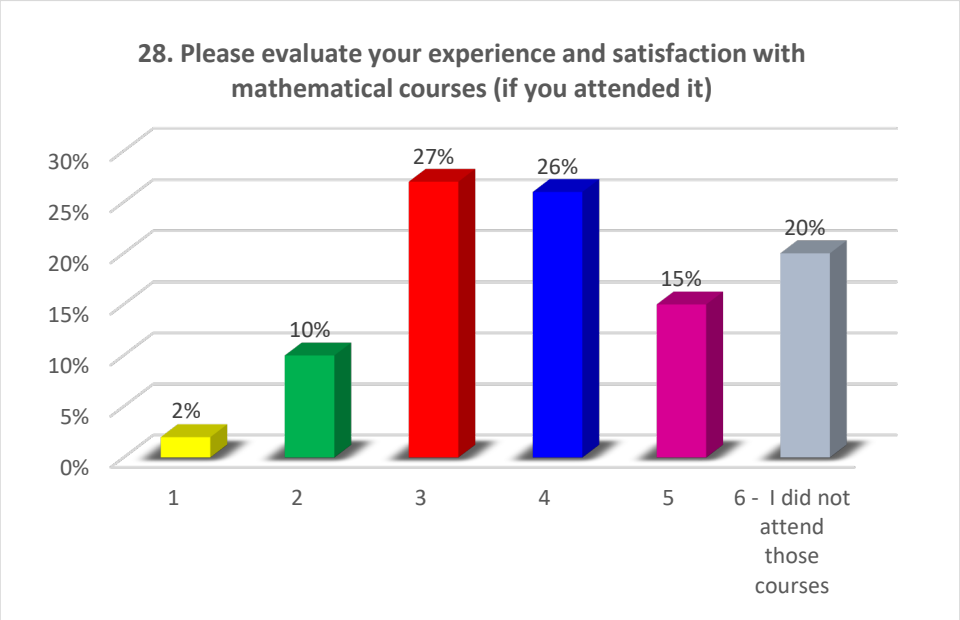


Figure 4.26. Evaluation of students experience and satisfaction with attending to courses of Mathematics I, Mathematics II, Mathematics III.

Students comments and suggestion for improvement were as follows:

- ✓ Pandemic situation has lowered the quality of the courses;
- ✓ Mathematical courses are useful in acquiring knowledge of both theoretical and practical parts;
- ✓ Mathematical courses cause improvement of students maths skills;
- ✓ Too much homework, too much exercises;
- ✓ Mathematical courses are not good.

As it was foreseeable, students opinion about learning and teaching mathematics during their study vary widely and they are divided: from a full understanding of the need to expand their mathematical skills and the usefulness of applying mathematics in other technical subject as well as in their future planned working life to total negation, dissatisfaction and even aversion. Probably such diversity of their opinions is caused by individual mathematical skills, individual students interest, hobbies related to the job and appraisal of teachers work what summarizes all responses in the survey. Students who have never had big problems with math say that problems with passing exams are more about students side and way of thinking not teacher's fault.

4. Conclusions

Analysing teachers and students responses we see that there are some kind of shortcomings and dissatisfaction in the process of teaching and learning mathematical subjects.

From one side of view, teachers mostly use traditional methods and tools. They are unsatisfied with students prior knowledge, their interest and motivation and the results of passing exams. They suggested that we - as university – should enrolled only that students who obtain high grades after high school and college graduation. Their attitude towards students is that they should understand that math will be a very important tool for other subjects during the whole study time.

From the other side students appreciate the efforts teachers do in the process of teaching but also do not recognize the importance of maths in future professions. They complain that : they need more time for exercises, more and more explanation by the teachers, the lessons should be placed not at the end of the day, but in the middle - it would be much more effective, some lecturers do not clearly specify what they require, teachers are old and they do not know how to use computer skills (!?)…

In conclusion there is a need to do the teaching and learning process better. To realize that the classroom activities should go on the following suggestions:

- Increase the level of student engagement ;
- More frequent use of internet resources, mathematical programs ;
- Point the importance of connecting the theory with solving problems from real life;
- Apply mathematical formulae to physics and other related subjects;
- Show students why mathematics is important for their future jobs.

In that sense teachers should transform their teaching from traditional methods and tools to the application of modern IT and solving math tasks by joining with real problems. Teachers should apply the modern tools to make their work easier and more satisfying by providing some available pre-made activities. It can be expected that, according to all students opinions, the above mentioned conclusions would make the lessons more interesting and even fun. Of course all of those activities should not cause the decrease in teaching effectiveness. Quite the contrary, they ought to support the learning process and boost the level of students mathematical skills, their accomplishments and acquirements.