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Online tests in Comprehensive Exams – during and after the pandemic

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Abstract. The Covid-19 pandemic accelerated the development of electronic (e-learning) assessment methods and forced their use worldwide. Many instructors and students had to familiarize themselves with the form of distance education. During and since Covid-19 in Hungary, at the Faculty of Engineering of the University of Debrecen, the written part of the Comprehensive Exam in Mathematics is organized in a computer lab of the university using an online test. Our goal is that the results of the tests may be as reliable as possible in terms of measuring the students' knowledge, and thus the grades given based on the test results would be realistic. In this paper, we show the analysis of a sample written exam and compare the real exam results of students who were prepared for the comprehensive exam during Covid-19 and who have participated in face-to-face education since then. The tools provided by the Moodle system necessary for comparison are also presented.

Key words and phrases: online assessment, online quizzes, online examinations, Moodle statistics.

MSC Subject Classification: 97D40, 97D70, 97U50.

Introduction

During the period of the pandemic, the teachers and instructors were able to gain a lot of experience about online education and how to conduct exams. Engineering students participating in the BSc program at the University of Debrecen, Faculty of Engineering conclude their two semesters of mathematics studies with a Comprehensive Exam. The Faculty's international students come from many places such as Algeria, Angola, Azerbaijan, Bahrein, Bangladesh, Brazil, Cambodia, Cameroon, Cape Verde, China, Ecuador, Egypt, Ethiopia, Germany, Ghana, Honduras, India, Iran, Iraq, Israel, Italy, Japan, Jordan, Kazakhstan, Kenya, Kosovo, Kuwait, Lebanon, Mexico, Moldova, Mongolia, Morocco, Nigeria, Oman, Pakistan, Palestine, Portugal, Qatar, Republic of Korea, Russian Federation, Saudi Arabia, Senegal, Somalia, South Africa, Spain, Sudan, Syrian Arab Republic, Tanzania, Thailand, Tunisia, Turkey, Uganda, Ukraine, United Arab Emirates, Uzbekistan, Venezuela, Viet Nam, Yemen, Zimbabwe, etc. Educating foreign students with diverse mathematical learning styles, skills and abilities requires a clear, transparent teaching and assessment system.

In the first semester, i.e., by the course Mathematics I, students get to know the basics of linear algebra and the analysis of univariate functions in the framework of a 4-hour lecture and a 4-hour practice per week. The topics of the course Mathematics II in the second semester are vector analysis (the time frame for this is 2 hours of lecture and 2 hours of practice per week) and ordinary differential equations (the time frame for this is 2 hours of practice per week).

The Comprehensive Exam for the international students can be divided into two parts: The written part is done by an online test in a computer lab of the university through the Moodle system, where the events are accurately documented (logged). The short name Moodle came from the expression Modular Object-Oriented Dynamic Learning Environment. The official website of the program is http://www.moodle.org. The oral part of the exam has to be taken on the same day as the written exam. In order to prepare for the oral exam, students are given the list of topics at the beginning of the second semester. The topics in the list mentioned cover the subjects Mathematics I and II. During the oral exam students are questioned verbally by an examiner teacher/lecturer to assess their knowledge of a topic. The number of topics published for students is 16. For instance, one of the topics of the oral exam is the following: “Classification of differential equations, initial value problems, slope fields, Euler’s and Runge–Kutta methods, problems leading to differential equations.” The examination described in this article does not deal further with the oral part of the Comprehensive Exam.

For the written part of the exam, a database of tasks had to be built in the Moodle system. In order for the obtained mark to reflect the student’s knowledge as accurately as possible, the task database must be revised and expanded.

For every university operating in attendance education, it can be a goal to develop an educational form and assessment method for their international students that will hold its own in an epidemic situation (similar to Covid-19).

In this article, we discuss the teaching and assessment methods developed for courses Mathematics I and II as subjects during the pandemic, which are, however, still helpful in preparing for the Comprehensive Exam nowadays.

Purpose of the study

During Covid-19, the students were prepared twice for the comprehensive exam in non-attendance education. These school years were September, 2019 – August, 2020 and September, 2020 – August, 2021. In the school years September, 2021 – August, 2022 and September, 2022 – August, 2023, the students participated in the seminars and lectures at the university.

In face-to-face education, the students were helped by the course materials uploaded to the Moodle system. Using the statistical data for the mentioned school years provided by the Moodle system, one of the goals of the study is the comparison of the students' grades for the comprehensive exam during distance education and face-to-face education.

The following research questions will be addressed: *Does spelling skills affect students' performance on short-answer questions? Which types of questions distinguish students who perform well from those who do not? Do students need the same amount of time to write the test during an in-person exam and an online exam?*

In this article, we also make suggestions for the further development of the examination method and the learning process.

Method

By the help of a sample test, we show what statistics e-learning produces and how we can use this to improve our database of tasks and the method of summative assessment. It is also important for the students, because the grade in the diploma is influenced by the grade of the Comprehensive Exam in Mathematics.

In addition to technical problems (e.g., lack of internet connection, suitable PC or laptop), it was difficult for international students to participate in online classes during the epidemic due to the different time zones. Although multimedia materials on the Internet make learning easier for students, a uniform notation system is important when learning symbolic mathematics. Taking the mentioned facts into account, narrated pdf files were prepared for the lectures of the courses Mathematics I and II. The online classes took place via video conference during the pandemic at the scheduled time. Then the participants were able to communicate continuously with the instructor via chat or video conference, and their requests were answered immediately. At other times, it was possible to communicate via e-mail and discussion forum. In the mentioned communication channels, according to experience, students asked their teachers questions more courageously, they were not "embarrassed" in front of the class, but they still received help to process difficult material for them. The reading and writing of mathematical formulas are very important parts of the learning and understanding process. During the online education, the instructors used different methods for this. For example, with a shared image of a webcam written on a white board, students could see the solution in each process of mathematical symbols. During the epidemic, we were able to experience the great community-shaping power of these communication channels.

For instance, the final grade of Mathematics II could be obtained in the following way.

Students wrote an online mid-term test and an online end-term test (40-40 minutes) on the full semester material of the ordinary differential equations part in the mid and at the end of the semester (at the scheduled date of the seminar); maximum 30-30 points could be achieved.

Students wrote an online mid-term test and an online end-term test (60-60 minutes) on the full semester material of the differential and integral calculus part in the mid and at the end of the semester (at the scheduled date of the seminar); maximum 50-50 points can be achieved.

After the tests within 5 minutes, students had to upload the photos of the handwritten solutions. The uploaded pictures had to contain the name of the student with printed capital letters and his/her Neptun code. Although the test questions were multiple-choice, required short answers, or required numerical data, in order to eliminate cheating, the handwritten solutions were also needed. With this method, students were required to be able to reason with mathematical symbols. Unfortunately, there is no way yet for students to be able to type in math symbols to show their solution steps. Before starting the testing, students had to login to a webinar / Webex link with webcam.

During the rest of the semester, students could collect supplementary points in the following way. In the last part of the video conference of the online seminars on four pre-assigned occasions, students wrote so-called mini tests on ordinary differential equations (10 minutes per test) and on differential and integral calculus (15 minutes per test). The mini-tests contained theoretical questions and practical tasks on the topics of the previous weeks.

The precise topics of the mini tests, together with sample mini-tests, would be available among the materials of the corresponding weeks in the e-learning course. For instance, corresponding to the topic "Gradient and Local Extrema", two of the mini test questions were the following.

A theoretical question:

Let $r_0 \in D$ *be a stationary point of a twice differentiable function* $f : D \subseteq \mathbb{R}^n \to \mathbb{R}$. *If the Hessian* $f''(r_0)$ *of* f *is positive definite, then... Choose one:*

(A) f *has a strict local minimum at the point* r_0.

(B) *all eigenvalues of the quadratic form defined by the Hessian matrix* $f''(r_0)$ *are strictly negative.*

(C) f *has a strict local maximum at the point* r_0.

(D) f *has a saddle point at the point* r_0.

A practical task:

Let $f(x, y, z) = ln(x) + y^3 e^2 z$. *Then the length (magnitude) of* $\operatorname{grad} f(1, 1, 0)$ *is... Choose one:*

(A) 2

(B) $\sqrt{2}$

(C) $\sqrt{14}$

(D) 1.

The extra points that result from the mini-tests can increase the student's final mark.

A similar assessment was used for the course Mathematics I. During the pandemic the form of the written test of Comprehensive Exam in Mathematics was similar to the tests used for Mathematics I and II.

Nowadays, for the exam grade of Mathematics I and II, students write the mid- and end-term tests on white papers in a lecture room at the university due to the lack of the required number of computer labs.

Exams with computer tests have many advantages. A unified structure can be provided, which improves transparency and the structure of the tests similar to above.

The evaluation is more objective, and the students do not question it either. It is important to mention that online billing is paper-saving and hygienic. Several lists of questions of the same type and difficulty can be randomly generated, and the results can be easily retrieved, thus simplifying the documentation and the generation of grades. A huge advantage is that the student can see his/her performance immediately (Dobák, 2011). Among other things, Dobák looked for the answer to whether it is possible to ensure that the online and traditional exams produce the same results. Her research results confirmed that it is very difficult to provide an environment in which this can be achieved. However, the participants of her experiment achieved better results on the online test than on the paper-based test.

In their paper, Al-Qdah and Ababneh (2017) investigates the effects of online exams on students' achievements and the students' perceptions of online and paper exams after taking an experiment on online and paper-based exams. The authors compared students' performance on paper-based and online tests for different types of questions. In their study, during the statistical analysis they found that the average and the standard deviation were similar, both the paper-based and the online exams include multiple choice questions, true or false and numerical type questions. The article of Shraım (2019) deals with the effectiveness and reliability of online exams.

According to Shraım's research subjects, the online exam type is preferable to traditional paper-based exams, for example, in terms of reliability of scoring, or considering costs. For instance, in the paper of Ocak and Karakuş (2021), we can read about the technical tasks and difficulties of online exams. The authors considered it important to mention that during the online exams, students could also feel nervous due to technical problems, such as connection problems. Of course, this could have been a problem during the pandemic. Nowadays, this anxiety can be reduced by the presence of the instructor in the lab. Stanković et al. (2017) outline the possibilities offered by the Moodle platform for Student Self-Assessment. In Moodle, Javascript must be enabled in the student's browser to display LaTeX formulas used to edit math questions. If this does not happen, the student will see a figure similar to Figure 1.

In order for students not to be "underperformers" on the online test, they must have a certain routine regarding the operation of the online tests. Therefore,

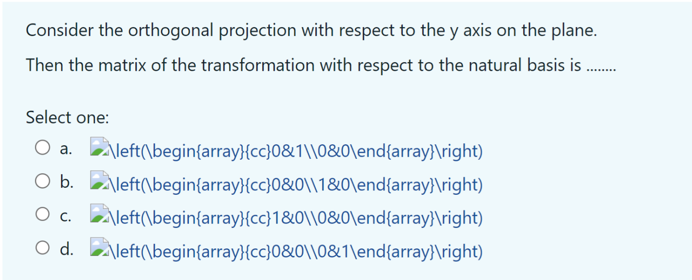


Figure 1. An online test question without Javascript

we saw it as appropriate to publish a sample test in the e-learning course belonging to the Comprehensive Exam in Mathematics.

The sample test included 10 theoretical questions and 10 practical tasks.

A maximum of two points could be obtained for each of the theoretical questions, there were no penalty points for incorrect answers. Each of the practical questions was worth three points, but -1 point was awarded for an incorrect answer.

During the pandemic if someone went to the next task, he/she could no longer go back to a previous one. With this decision, we wanted to reduce the possibility of fraud. Candidates were given information about the rules before the start of the test, such as "After the 'Next page' button you cannot go back to the previous question. Each exercise has only one right answer. Correct answer: 3 pts; wrong answer: -1 pt; no answer: 0 pt. Theoretical questions: 10×2 pts; exercises 10×3 pts, i.e., maximum 50 pts can be achieved. Mark ranges: ≤ 24 pts: fail (1); 25-34 pts: pass (2); 35-42 pts: satisfactory (3); 43-50 pts: satisfactory (3) or the student takes an oral exam for grade (4) or (5)."

Nowadays, in the lab of the university, students can go back to a previous question. We came to this decision after talking to students with good abilities. They told that, because of not knowing how much time they would need to solve the remaining tasks, they preferred to skip a task if they could not solve it immediately.

The sample test was started 2010 times and there were 233 completed attempts. 59 students tried the test once, the majority of students 2-6 times. There was a student who took the same test 98 times. The data primarily provided by the Moodle system for the sample test results completed by the students are contained in the following Table 1.

Average grade of first attempts	25.99%
Average grade of all attempts	23.33%
Average grade of last attempts	38.62%
Average grade of highest graded attempts	53.61%
Median grade (for highest graded attempt)	58.00%
Standard deviation (for highest graded attempt)	38.17%
Score distribution skewness (for highest graded attempt)	-0.1573
Score distribution kurtosis (for highest graded attempt)	-1.6096
Error ratio (for highest graded attempt)	23.11%
Standard error (for highest graded attempt)	8.82%

Table 1. The statistics of the sample test (Comp. Exam)

According to Moodle (see Quiz report statistics), the average is between 50-75%, if it falls outside this range, it is worth changing the list of tasks. If there is no large difference within the data set, then the median is a number close to the average (arithmetic mean), which can be said here for the best classified attempts. The standard deviation informs us how much the student scores are spread around the arithmetic mean, how each student's scores are located on average.

One of the reasons for the large deviation may be that the students complete the sample test without preparation, there is no stake. Other reasons can also be seen from the data provided by Moodle: since when editing the test, we did not indicate that the students would receive the correct answers to the tasks as feedback, i.e., that they would find out the correction key, the students figured out by trial and error what it could be.

If the asymmetry is an absolute value greater than 1, then there is no adequate differentiation within the "mass". Since it is a negative number here, the mass was slightly better than the average (the frequency curve is roughly symmetrical; the basis of comparison is always the frequency curve of a normal distribution with the same standard deviation).

The optimal value of kurtosis is between 0 and 1. Here, the frequency curve is flatter compared to the frequency curve of a normal distribution with the same standard deviation.

The error ratio shows here that 23.11% of the dispersion of scores is random, and the remaining 76.89% is due to the different knowledge of the students.

The standard error shows the amount of random error in each student's scores. 8% usually represents a grade difference, so we can conclude from the results that some of the students will be poorly graded. Quiz structure analysis also can be downloaded in different formats such as csv, xlsx, etc.

Moodle offers 17 types of questions when editing the question bank (Vámosi, 2017). In the sample test, six of the ten theoretical questions were multiple-choice (M), three required short answers (A) and one required numerical data (N). Table 2 contains the statistics of theoretical questions.

Q. Nr	Type	Facility index	Standard deviation	Random guess score	Intended weight	Effective weight	Discrimination index	Discriminative efficiency
1	M	72.10%	44.95%	25.00%	4.00%	3.62%	50.78%	64.06%
2	M	66.52%	47.29%	25.00%	4.00%	3.90%	56.40%	65.62%
3	A	68.24%	46.65%	0.00%	4.00%	4.00%	60.79%	72.07%
4	A	45.06%	49.86%	0.00%	4.00%	4.33%	67.26%	75.33%
5	N	59.23%	49.25%	0.00%	4.00%	4.48%	73.65%	81.22%
6	M	57.51%	49.54%	25.00%	4.00%	4.52%	74.64%	81.76%
7	A	47.21%	50.03%	0.00%	4.00%	4.45%	71.04%	78.45%
8	M	69.10%	46.31%	25.00%	4.00%	4.17%	67.38%	81.31%
9	M	60.52%	48.99%	25.00%	4.00%	4.40%	71.14%	79.13%
10	M	59.23%	49.25%	25.00%	4.00%	4.52%	74.89%	82.41%

Table 2. The statistics of theoretical questions (sample Comp. Exam)

According to Moodle, the Facility index can be interpreted as a percentage as follows:

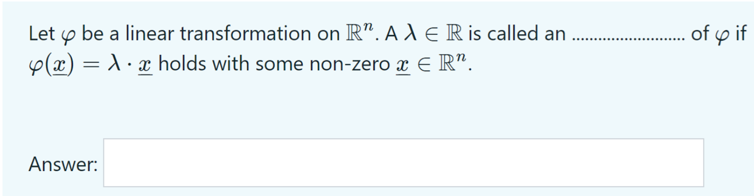
For < 5, the assigned task is very difficult or bad, from 6 to 10 very difficult, from 11 to 20 difficult, from 21 to 34 a little difficult, from 35 to 65 average, from 66 to 80 fairly easy, from 81 to 89 easy, from 90 to 94 very easy, from 95 to 100 extremely easy.

It can be read from the table that six of the tasks of the sample test are average and four are quite easy based on the sample tests completed by the students.

Question 4, which required a short answer, proved to be the "most difficult" for the students.

Care must be taken when editing the question to be supplemented when specifying the answer alternatives, especially for foreign students, as shown in Figure 2.

From the quiz structure analysis it can be easily seen that out of 233 students, 92 answered "eigenvalue", 13 answered "Eigenvalue", 12 answered "eigen value", 5 answered "eigenvector", 83 did not answer.


Let φ be a linear transformation on $\mathbb{R}^n$. A $\lambda \in \mathbb{R}$ is called an .... of φ if $\varphi(\underline{x}) = \lambda \cdot \underline{x}$ holds with some non-zero $\underline{x} \in \mathbb{R}^n$.

Answer:

Figure 2. Theoretical Question 4 and the answers (sample Comp. Exam)

Thus, the answer to the first research question is ‘yes’, i.e., spelling skills affect students’ performance in short answer questions.

If the Facility index is very high or low, then the standard deviation should not be large.

We see no such example here. Apparently, the students did not score points for the supplementary and numerical questions by guessing randomly. For multiple-choice questions, the “random guess score” can be interpreted as a percentage; above 40% is unsatisfactory. In the sample test, there were 4 possible answers for the multiple-choice questions. There was no penalty point for the theoretical question, so it is worth guessing.

The intended weight shows what percentage of the total score we plan to obtain for the question. The effective weight shows what percentage of the standard deviation of the test scores comes from the given question. Ideally, the difference between effective and intendent weights is not large.

The so-called discrimination index shows the correlation between the score achieved on the given question and the score achieved on the other questions, expressed in %. Essentially, this shows how effectively the given question can distinguish between good and less good students. However, its interpretation is somewhat difficult because its maximum is not always 100%.

According to Moodle, the given question discriminates very well if the discrimination index expressed in % is greater than 50. Good discrimination is from 30 to 49, poor from 20 to 29, and very poor from 0 to 19.

Very easy or very difficult questions should not differentiate between students of different abilities. A discrimination efficiency below 50% means that the question is not really effective in discriminating. Moodle highlights questions in red if the discriminative efficiency is below 15%.

Regarding the ten practical questions, it should be noted that all tasks proved to be of average difficulty for the students, see Table 3. Questions 13 and 14 were related to the topic of integral calculus, the discriminative efficiency was the highest for these questions. The situation was the same in most of the real exams, so we got the answer to the second research question.

Q. Nr	Type	Facility index	Standard deviation	Random guess score	Intended weight	Effective weight	Discrimination index	Discriminative efficiency
11	M	49.36%	56.57%	-6.67%	6.00%	5.80%	69.47%	74.24%
12	M	49.93%	55.37%	-6.67%	6.00%	5.91%	74.49%	79.69%
13	M	51.36%	55.18%	-6.67%	6.00%	5.94%	75.72%	81.45%
14	M	59.51%	52.21%	-6.67%	6.00%	5.81%	77.13%	86.62%
15	M	41.63%	55.95%	-6.67%	6.00%	5.59%	64.29%	68.76%
16	M	54.65%	54.65%	-6.67%	6.00%	5.76%	71.25%	77.43%
17	M	41.49%	55.58%	-6.67%	6.00%	5,64%	66.15%	71.25%
18	M	50.79%	54.32%	-6.67%	6.00%	5.76%	71.88%	77.25%
19	M	49.64%	55.20%	-6.67%	6.00%	5.65%	67.22%	71.82%
20	M	42.06%	56.52%	-6.67%	6.00%	5.75%	68.03%	72.86%

Table 3. The statistics of practice tasks (sample Comp. Exam)

Considering the intended and effective weights, it can be said that none of the practical tasks has as much of a role in the deviation of points as it was planned, but it is quite close to the intended one.

Participants, data collection and analysis

In the second semester of the 2019–2020 and that of the 2020–2021 school year, students took the online Comprehensive Exam in Mathematics from "home". In these semesters, approximately three quarters of those who applied for the exam were also participants.

In the second semester of the 2021–2022 and 2022–2023 school years, when the exams were organized at the university in a computer lab, only half of the students who applied were participants, for the exact data see Table 4. The quiz in the lab has been configured so that students may only attempt it using the Safe Exam Browser. Before starting the testing, students had to login to a webinar / Webex link with webcam. The students could then start the test. The webcams had to remain on for the entire duration of the tests.

	The number of students who applied for the comprehensive exam / who participated in the comprehensive exam
2019–2020, Semester II	124 head / 98 head (i.e., 79% of those who applied participated)
2020–2021, Semester II	188 head / 139 head (i.e., 74% of those who applied participated)
2021–2022, Semester II	167 head / 87 head (i.e., 52.1% of those who applied participated)
2022–2023, Semester II	205 head / 106 head (i.e., 51.7% of those who applied participated)

Table 4. Attendance on the Comprehensive Exam in Mathematics

Findings

What is the reason for the considerable difference? Maybe the students actually sat at home and they devoted much more time to studying during the pandemic. *Were the narrated pdf-s and the many communication options an effective help in learning the course material?*

Are students under less pressure than in the classroom? Of course, there can be many other reasons, the answers to the questions require investigations. A study of Jiang et al. (2023) aimed to investigate the potential factors of students' online proctoring acceptance. Lim et al. (2021) examine the effects of instructor presence and online learning self-efficacy on learning satisfaction, and how the effect of social presence may depend on content structure. According to the authors' investigation, the presence of instructors is definitely justified where teaching and learning involve several interpretation processes.

By Table 5, the development of grades can be seen over 4 semesters. For example, in Semester II, 2019–2020, 12 out of 98 students received grade 1 (fail) on the second attempt, i.e., approximately 12.2% of the students who were not able to take the exam successfully on the second try.

It can be seen from the Table that during the semesters the students gained a routine in order to achieve grade 2 on the exam on the first attempt. This may be due to the fact that the students who have already passed the exam passed on their experience to the new students. On the other hand, during the teaching of Mathematics I and II, questions similar to those in the Comprehensive Exam's question bank appeared more and more frequently during the semesters.

It also seems to be confirmed by Figure 3 that, in terms of the proportion of students, they received better grades in Semester II, 2020-2021 than in the others.

	2019–2020, II – from “home”					2020–2021, II – from “home”				
	1	2	3	4	5	1	2	3	4	5
From Attempt 1	14.3	14.3	20	11.2	2	6.5	17.3	19.4	11.5	0
From Attempt 2	12.2	9.2	8.2	5.1	2	6.5	12.2	10.8	8.6	0.07
From Attempt 3	0	1	0	0	0	0	0	5	1.4	0

	2021–2022, II – in a lab					2022–2023, II – in a lab				
	1	2	3	4	5	1	2	3	4	5
From Attempt 1	20.7	21.8	11.5	2.3	5.7	17.9	24.5	12.3	7.5	6.6
From Attempt 2	3.4	14.9	4.6	2.3	3.4	5.7	11.3	8.5	2.8	0.09
From Attempt 3	3.4	1.1	2.3	0	2.3	0	2.8	0	0	0

Table 5. The development of grades

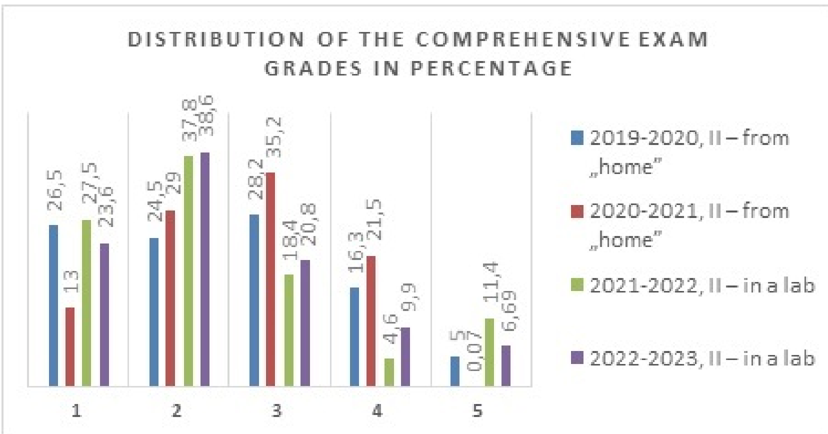


Figure 3. Distribution of Comp. Exam grades in percentage

Based on the real tests, it became clear which tasks the students could not solve correctly. Surprisingly, few students were able to solve tasks similar to the set theory task shown in Figure 4.

During the exams held in the lab, it was realized that the majority of students had forgotten the meaning of the $\times$ symbol in this context.

If we integrate mathematical modeling ideas and methods into the teaching of higher mathematics, then we can improve students' ability to find, analyze and solve engineering problems; we can read about this in (Rong, 2017), among others. We showed many examples of engineer application in the Mathematics I

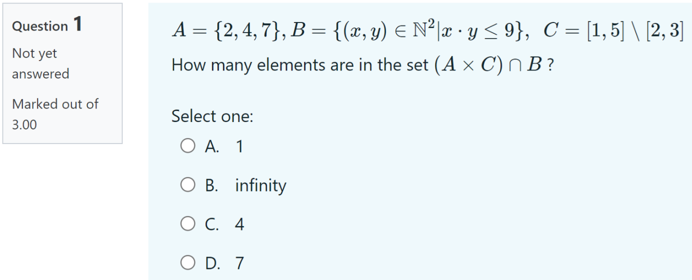


Figure 4. A practice test question from the set theory

and II seminars. Teachers use the same examples for all majors due to lack of time.

Initially, engineer examples are appeared in the Comprehensive Exam tests. However, the analysis of the test structure showed that these questions are very divisive among students. This is understandable considering that if a student sees an engineer example mentioned in a mathematics course in another specialized course, it is better memorized. Such an engineering student has an advantage on the Comprehensive Exam in Mathematics over someone who has not encountered the given question type in another course. In the future, we have to be careful about questions of this kind in Comprehensive Exam in Mathematics.

Now, the third research question will be answered. The students were given 3600 seconds to solve the written part of the Comprehensive Exam. Online measuring allowed us to download the time spent on tasks from the Moodle system, thus we can analyze and compare them with the achieved results. The time spent on solving the test was examined and compared in the two cases when the students took the exam from "home" and in a computer lab at the university. The average time consumption can be found in Table 6 with respect to the indicated scores. Obviously, the environment also had an impact upon the solution. At home, the student could be distracted by fewer things than in a lab, but the Internet connection at home could fail. It is worth mentioning that in both examined cases there is a difference of more than 5 minutes between the students who received grade 3 and the students who received grade 4 or grade 5 in terms of the average solution time. Another interesting thing is that the data also shows that the failed students finished solving the test an average of 3 minutes later than in the lab. So low-performing students give up writing tests in the lab sooner than at home. High-achieving students, on the other hand, are faster in the home environment, probably because they can concentrate better.

Scores	Average time consumption at "home"	Average time consumption in a lab
≤ 24 pts (grade 1)	3324 sec	3128 sec
25-34 pts (grade 2)	3292 sec	3227 sec
35-42 pts (grade 3)	3212 sec	3298 sec
43-50 pts (grade 4 or 5)	2873 sec	2946 sec

Table 6. Average time consumption

Discussions and conclusion

During the pandemic, instructors created a number of task bases in the Moodle system. Randomization can reduce the possibility of cheating through a question bank containing a sufficient number of tasks (Shraım, 2019). In the case of a multiple-choice test, the instructor must essentially make sure that the compiled question bank is suitable for the evaluation. In order to do this, the development of the task database must be preceded by a statistical investigation. By taking into account the analysis of the test structure, it can only be achieved that the results of the tests be as reliable as possible in terms of measuring the students' knowledge and thus the grades given based on the test results be realistic.

Based on the above, our plans in the future are as follows. We also want to use penalty points in the multiple-choice theory questions so that there is no point in guessing. When editing the supplemented questions in Moodle, many more alternative answers must be given (taking student mistakes into account). Replacement of one or two practical tasks with less difficult ones are needed in order to distinguish the "pass (2)" students from the "satisfactory (3)" students.

During the semester, it would be advisable to make it mandatory for the students to successfully complete the online sample tests at the end of each course subject to a deadline, thereby encouraging regular learning.

In the future, the goal is to develop talent management through a hybrid form of education. Excellent students would study courses Mathematics I and II, as during Covid-19, and even the others in face-to-face education. Talented students can thus progress with the curriculum at a faster pace and devote more time to the study of engineer processes and their mathematical models. The future aim is to work out the educational form of cooperative project-based learning for the talented students of different engineering majors.

References

Al-Qdah, M., & Ababneh, I. (2017). Comparing online and paper exams: Performances and perceptions of Saudi students. *International Journal of Information and Education Technology*, *7*(2), 106–109.

Dobák, D. (2011). *Az online vizsgáztatás pedagógiai jelentősége* [Doctoral dissertation, Eötvös Loránd University]. ELTE Digital Institutional Repository. http://hdl.handle.net/10831/45029.

Jiang, X., Goh, T.-T., Chen, X., Liu, M., & Yang, B. (2023). Investigating university students' online proctoring acceptance during COVID-19: An extension of the technology acceptance model. *Australasian Journal of Educational Technology*, *39*(2), 47–64. https://doi.org/10.14742/ajet.8121

Lim, J. R. N., Rosenthal, S., Sim, Y. J. M., Lim, Z.-Y., & Oh, K. R. (2021). Making online learning more satisfying: The effects of online-learning self-efficacy, social presence and content structure. *Technology, Pedagogy and Education*, *30*(4), 543–556. https://doi.org/10.1080/1475939X.2021.1934102

Miao, R. (2017). Applied value of mathematical modeling thought in advanced mathematics teaching. In *Proceedings of the 6th International Conference on Social Science, Education and Humanities Research (SSEHR 2017)*, Advances in Social Science, Education and Humanities Research, Volume 185 (pp. 164-167). Atlantis Press.

Ocak, G., & Karakuş, G. (2021). Undergraduate students' views of and difficulties in online exams during the COVID-19 pandemic. *Themes in eLearning*, *14*, 13–30.

Quiz report statistics.https://docs.moodle.org/dev/Quiz_report_statistics

Shraım, K. (2019). Online examination practices in higher education institutions: Learners' perspectives. *Turkish Online Journal of Distance Education*, *20*(4), Article 12, 185–196.

Stanković, J., Milovanović, S., & Radović, O. (2017). Applying the Moodle platform in online student self-assessment. *Economic Themes*, *55*(2), 281–304. doi:10.1515/ethemes-2017-0016

Vámosi, A. (2017). Tippek és trükkök Moodle számonkérés készítéséhez [Tips and tricks for creating a Moodle assessment]. *International Journal of Engineering and Management Sciences (IJEMS)*, *2*(2), 123–131.

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