CHANGES IN LEARNING STRATEGY AND LEARNING TIME IN THE WAKE OF THE PANDEMIC

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ABSTRACT

University studies were also significantly affected by the pandemic. The first-year students had already spent the last months of high school, which are especially important for graduation, in distance learning. In Hungary, the graduation procedure was changed due to the epidemic. Education was completely digital in hybrid form: the lectures were held online, and the seminars were attended in-person and from September of 2021 again in-person. Our research team has been monitoring learning time and effectiveness for years using the EduBase online educational platform, which provides a framework for all teaching aids for the calculus subject. In our research, we analysed the learning processes and their effectiveness of mechatronic and energy engineering students who were admitted to BME in 2020. The results were compared with the learning habits of the class of 2018, with whom a detailed study was also performed. It can be stated that the pandemic greatly influenced the learning time: students took advantage of the available practice opportunities to a greater extent in digital education, which did not reduce the practice time during the end-of-semester spurt, thus, learning became more balanced. Considering the high school results, it can be observed that on average, those who took advanced level subjects spent more time practicing, even though they had

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already mastered some calculus in high school. In addition, test scores also influenced practice time, while students coped successfully even with the more difficult tasks.

INTRODUCTION

The transition from high school to university is challenging for students even without the difficulties of the epidemic. In 2020, it was especially difficult for graduates. Knowing that the first-year students had already spent the last months of high school in online education, and due to the epidemic, only hybrid education is implemented at the Budapest University of Technology and Economics, we paid special attention to our students' learning. In the summer of 2020, we created a carefully compiled workbook. During the online lectures, the students were able to fill in the missing parts of the workbook (e.g., proofs, examples) and take notes on it. During the semester, a video was created for each topic weekly, in which we presented a detailed solution to exercises. In the EduBase online education platform, students had parameterized practice exercises for each topic. Thus, each time they entered the platform, they got a different task. The students could do their weekly homework also in this EduBase system. Furthermore, they wrote the first and second midterms and the exam via this same platform. Lectures and weekly consultations took place at MS Teams. Therefore, the whole learning process became easy to monitor. For each student, we could see every day how much time they spend on the calculus subject (e.g. doing homework, practicing), when and how effectively they deal with the material.

We have carried out similar monitoring in previous years [1],[2],[3], while attendance education was still ongoing. The main result of these studies was the following: although students willingly learn using the online platform, towards the end of the semester, when their duties accumulate, they spend much less time practicing. We knew that we need to pay close attention to this in this pandemic and try to prevent this decline. At the beginning of the semester, we tried to assess the students' level of knowledge, skills, and level of thinking with several tests. Thus, we attempted to screen out students who may have difficulties during the semester to help them if needed. We assigned senior tutors to our students. A tutor dealt with 10-15 students, paid more attention to them, and held individual consultations for them. Both tutors and teachers were very enthusiastic and engaged with the students to help them successfully overcome the obstacles of the transition to higher education.

1 DATA AND METHODS

1.1 Investigated group

The students in our study population were admitted to two majors with the highest admission scores of the leading technical institution in Hungary. In 2020, the 433 points were for mechatronics, and 349 points for energy engineering were the inclusion point limit. A maximum of 500 points can be earned [4]. The average admission score of the mechatronics in our study population is 459 points, the standard deviation is 15, while the average score is 421.5, and the standard deviation

is 33 points for energy engineering students. A large proportion of students came from a high school where they studied mathematics or science subjects in a higher number of hours. This ratio is 51.6% (32 students) for energy engineering students and 51.1% (47 students) for mechatronic students. 59 (64.1%) of the mechatronics students and 41 (66.1%) of the energy engineering students graduated in advanced level in mathematics. They studied math at an advanced level, which means they had at least 5 math classes a week as a high school student. Furthermore, their high school curriculum included differential and integral calculus, meaning that they had already learned a lot about what is described in the calculus subject.

1.2 High-school learning method during pandemic

It can be seen that 20% of energy engineering students had no part in any education, while this proportion was approximately half in the case of mechatronic students. This is a significant proportion, considering that students come from good ranked high schools for these majors.

2 TEACHING PROCESS

2.1 Course structure and requirements

For first-year energy engineering and mechatronics students, the calculus subject consists of 2x90 minutes of lectures and 1x90 minutes of seminars per week. The condition for participation in the oral and written final exam is successfully completing first and second midterm and tests at least 40%. The final grade is determined as follows: a student can get a maximum of 100 points during the semester, 20-20 points for the tests, 60 points for the written final exam, in addition to 10 extra points for additional optional tasks. Based on their score, students will receive a recommended grade. The final grade is obtained with a maximum deviation of ± 1 grade from the recommended grade based on the student's performance in the oral exam.

2.2 Education method during the semester

The first six weeks of the autumn semester went as so-called hybrid education at Budapest University of Technology and Economics: the lectures were held online, the seminars in the traditional, attendance way. Due to the worsening epidemic situation, the university switched entirely to online, distance education from the second half of the semester (November 16, 2020).

2.2.1 Lectures

The lectures of the calculus course were held online throughout the semester via the MS Teams system. At the scheduled time, the students were able to participate in the lecture together with the lecturer, at the same time. Thus, they could immediately ask their questions and react to the learning material. All lectures were recorded so students could watch them at any time after the scheduled time. A workbook was prepared for the lectures, which already contained the most important definitions and

items, thus helping to take notes. However, there were omitted parts (e.g proofs and examples), thus encouraging the students to actively participate and pay attention to the lectures.

2.2.2 Seminars

The seminars were held in the traditional, attendance way with small groups during the hybrid system. Nevertheless, all seminars were uploaded to the EduBase digital classroom in a video format so anyone could watch them again, especially those who were unable to attend the seminars due to the pandemic. At the end of the attendance seminars, the students wrote a small test for one extra point from the material of the given lesson. In the second half of the semester, during the online education, the videos of the seminars had already been uploaded at the beginning of the week, and students had the opportunity to consult in the scheduled time of seminars via the MS Teams.

2.2.3 Homework

Throughout the semester, students had the opportunity to complete homework in the digital classroom for extra points and practice on quiz sets after the submission deadline of homework. In the first half of the semester, while the seminars were also held in attendance, students were able to begin completing their homework after the scheduled time of these seminars. In the second half of the semester, the homework always opened on Mondays after the seminar videos were uploaded into the digital classroom. The EduBase system allowed us to track students' learning processes. The first and second midterms, as well as all the written final exams were also conducted via this EduBase platform.

2.3 Education platform - EduBase

Online education was implemented with the unique testing and examination system of the cloud-based education platform EduBase (www.edubase.net) [1],[5].

3 RESULTS

3.1 Study-time patterns

The figure below (Fig. 1) shows how many seconds students worked in EduBase. Outlier data are not presented. Very short practicing (shorter than 600 s) was not considered. The horizontal axis shows the time of practice in hours and the vertical axis shows the number of entries. The approximately half-hour practice time is the most common. Students often practice for between half an hour and an hour, while practice times longer than 60 minutes are becoming less frequent.

Comparing data from the 2018 pandemic-free semester with 2020, it can be seen that more people practised for longer periods during the pandemic. The detailed analysis of the data also revealed that in 2020 there were 26 students (both populations were made up of nearly the same number of students of the same ability) who practiced more than 40 hours, compared to only 8 in 2018.

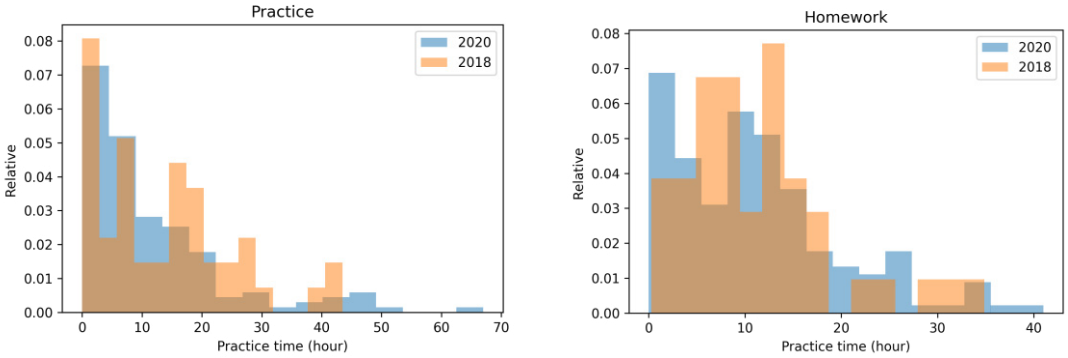

Fig. 1. Distribution of time worked during the semester

Fig. 2 shows how the opening of homework and practice quiz sets developed during the semester. The more intensive preparation for the first and second midterms in the middle of the semester and at the end of the semester is clearly visible with outstanding peaks. In these two cases they practiced more often and more. The peaks seen in late December and January are the preparation peaks for final exams. In these cases, if we compare the peaks to the number of participants in each final exam, we can say that the preparation takes approx. the same for all final exams.

The most remarkable difference between the autumn 2018 semester (left graph in Fig. 2) and 2020 (right graph) is that in 2020, students spent more time practising and solving homework in the second half of the semester. It can also be seen that learning was more even, which has a positive impact on learning efficiency [2], [3]. The data are in accordance with our experience: in pandemic-free periods, in the last weeks of the semester, students are usually so overloaded that many of them are already "struggling to survive", attempting to solve only the compulsory tasks in an acceptable way. Preparing for exams (highlighted in red) during the pandemic is also more characterised by distributed learning throughout the semester.

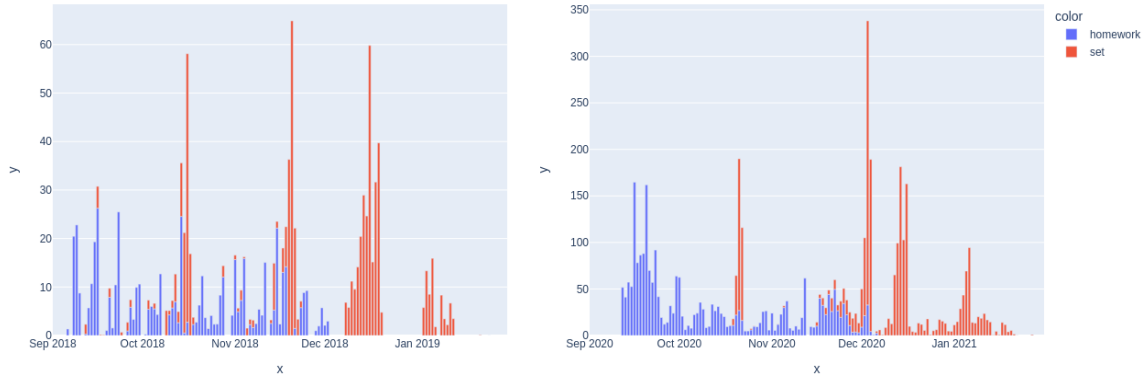

Fig. 2. Distribution of total homework and practice quiz set openings

The homework of the current week was open on Thursdays (after seminar) during hybrid education and on Monday evenings during entirely online education in the second half of the semester. Students had one week to solve their homework. Thus, for the online period, Monday midnight was the submission deadline of homework assignments. Examining the daily distribution of openings, we found that practice began most often on Wednesday, while homework was most often done on Thursday. Weekends were not preferred for practice or doing homework. We consider this fact important as it suggests that the students did not leave the preparation at the last minute, they tried to distribute the practice evenly.

Figure 3 shows the weekly distribution of learning time in 2018 and 2020. The peaks are the days of the week. In 2018, many students were most engaged with the curriculum the day before the deadline (Sunday high peak), while in 2020 the peaks show a much more even spread of learning.

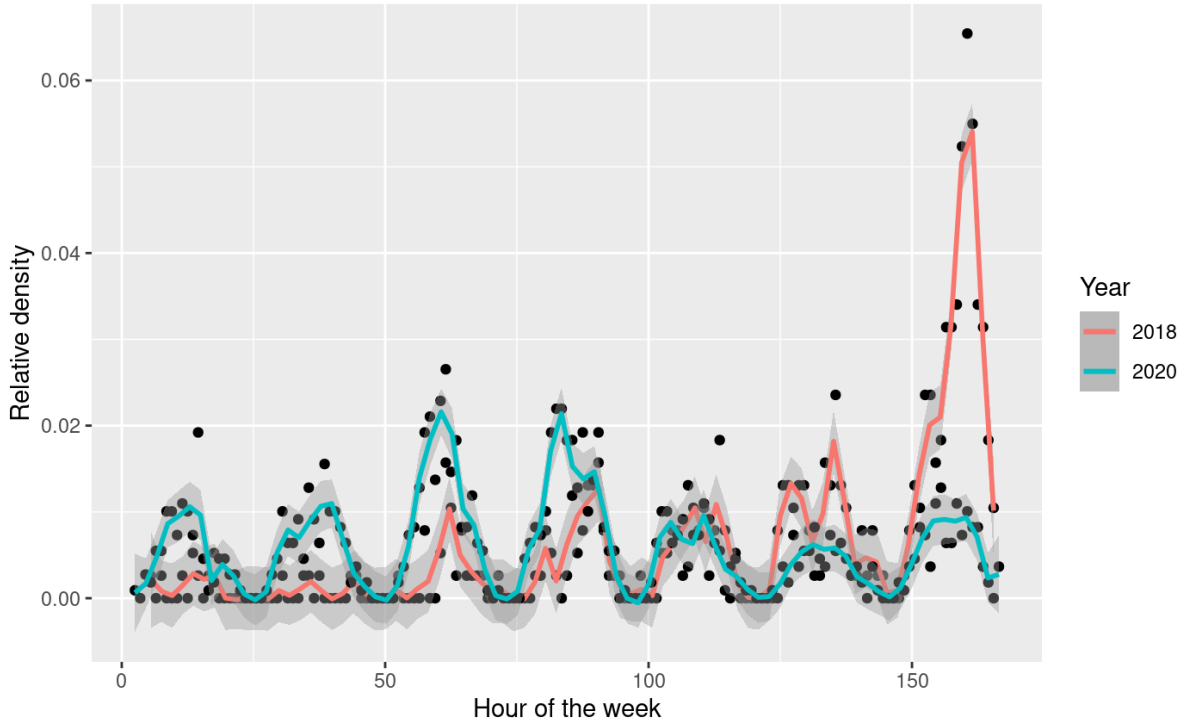

Fig. 3. Distribution of weekly homework and practice time

3.2 Test results

Let's see how students with different study periods performed in the tests in the autumn semester 2020. In the graph, the size of the dots is proportional to the time spent studying, the larger the dot, the more time the student is spending studying. Each dot represents one student.

Figs. 4 and 5 show the relationship between the results of the first and second midterms of the calculus subject and the results of the mathematical-language test

written in the first week for each student. The math-language test was written to estimate the level of knowledge of the incoming students. The language part is unusual in technical higher education. The purpose of this section is to compensate for the distorting effect of excessive preparation for mathematics tasks [7]. Each dot in the figures represents one student. The radius of the circle is proportional to the online learning time (outlier data have been filtered out). The students marked with a blue dot attended a special mathematics or science class during high school, so mathematics had a greater emphasis in their high school education. Students marked with a red dot only attended basic maths lessons. Based on the figure for the first midterm, better math-language tests were generally coupled with better first midterm results. Furthermore, those who spent less time practicing and learning, rarely achieved good results. Although, you can see a few blue circles with a small radius and good results. This can be explained by the fact that the material of the first midterm was already discussed deeply in the special mathematics or science classes during high school.

Fig. 5 shows the results of the second midterm. The chart can be divided into 4 rectangles. As mentioned earlier, the second midterm mainly contained material that was not encountered or just mentioned in high school. The light blue rectangle in the lower left contains students with little incoming knowledge who also perform poorly at university. Luckily, it includes only one student who, as the size of the dot shows, didn't spend much time practicing. In the lower right, light green rectangle, the students did poorly on the mathematics-language test, but apparently practiced a lot during the semester, and the second midterm was already written with good results. Students in the purple rectangle in the upper left, despite writing a good math-language test, practiced little and were not successful in the second midterm. The students in the upper right, yellow rectangle performed well on both measurements, and many of them also devoted a lot of time to practice. Only a few small radius circles can be seen in this range.

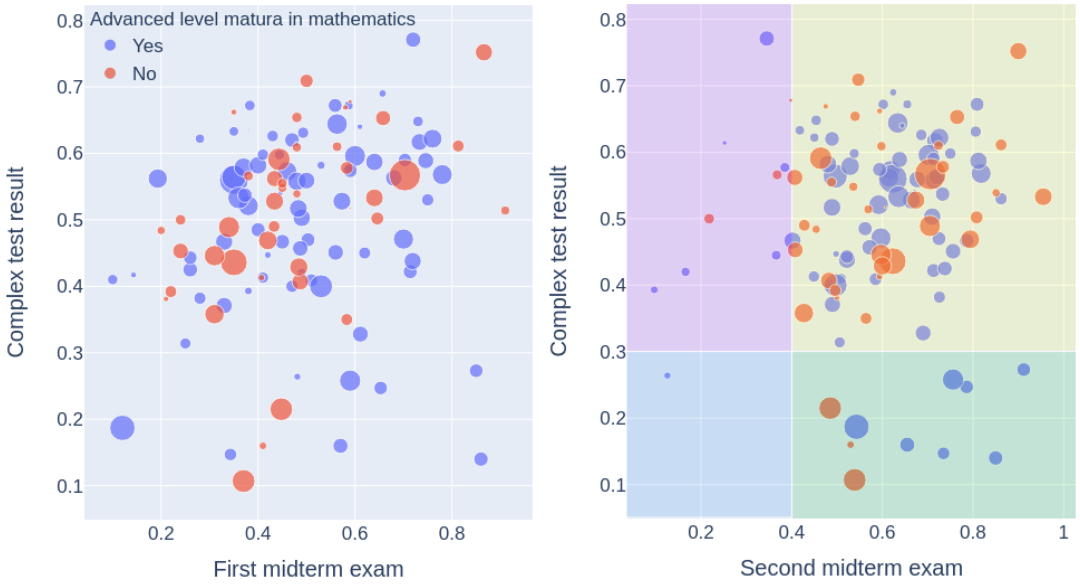

Fig. 4. (left) Relation of student performance on the 1st midterm exam and on the complex test result

Fig. 5. (right) Relation of student performance on the 2nd midterm exam and on the complex test result

4 CONCLUSION

As a conclusion, it can be stated from the detailed analyses of this partly hybrid and partly online semester that first-year students could solve the difficulties of the pandemic situation. Instead of the campaign-like learning that is so common in higher education, providing inadequate knowledge in the long term, students worked evenly, mostly devoting an adequate amount of time to learning. They did the calculus exam well. 20 (13%) students earned excellent grades, 34 (22%) good grades, 51 (33%) fair grades, 31 (20%) sufficient grades, while 16 students failed. The exams consisted of two parts, a 90-minute online written exam with numerical exercises, followed by an oral test on theory. The results were a little lower than usual, but when compared to the results during the pandemic, it was outstanding. In the case of exams with only an online written part, it was common to see better results than before during the pandemic, but much poorer results in the oral part. In calculus, the EduBase fraud detection system did not detect the same bias as in the written exams in other subjects. The slightly weaker results in the oral test could also be explained by the fact that there were no oral exams in Hungary in spring 2020, so that students had their first opportunity to orally test their knowledge of a large amount of material at university. Learning and then orally reproducing a large amount of theory was not easy for many.

For the academic year 2021/2022, education at our university was conducted in-person. For our students, this was more of a start than a return, as it was the first time during their university studies that all their classes were taught in-person format. Calculus 3 is the last regular mathematics course, followed by a comprehensive exam. In the autumn semester of the 2021/2022 academic year, we have tried to implement the distributed learning experienced during the online period. We also monitored the Calculus 3 course in EduBase. The analysis of these data and the comparison with the same subject in the previous academic years is still ongoing, and we intend to publish our results in further contributions.

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