The Influence of Educational Technologies and Students' Academic Disposition on Their Study Success in the First Year at University

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***Abstract*—The paper presents the results of the research on student success in the first year at Faculty of Transport Engineering, University of Pardubice, Czech Republic. The research focused on the issue of students and their academic disposition as well as on the educational technologies used within the framework of teaching mathematics in the first semester at the university. The research included both full-time and part-time students. During the semester, the students had the opportunity to attend lectures, seminars and one additional seminar. The available study aids were in the form of printed textbooks supplemented by compact discs, which included video recordings of the procedures used to solve the problems and exercises discussed. Additionally, the video recording of the current lecture was published using the university intranet after every lecture. The research aimed to find out which educational technologies are convenient for different groups of students and how they affect the student attendance at lectures and seminars. The research was conducted using a questionnaire. The obtained data were statistically evaluated. The research proved that full-time students use their notes from lectures and especially from seminars to study. Part-time students use the multimedia textbooks and the video recordings of lectures the most. The publication of the lecture video recordings has a slightly negative effect on the student attendance, but they are beneficial for the majority of students.**

***Index Terms*—Approaches to study, higher education, lecture video recording, quantitative analyses, student attendance, teaching mathematics.**

I. Introduction

When researching the study success of students in their first year at university, it is necessary to focus not only on the actual university studies but also on students' academic disposition. The transition from a high school to a university brings about a fundamental change for every student not only in the area of social relationships but especially in their approach to studying. Far from every student manages to cope with this transition. The question is whether it is possible, within the framework of the admission procedure of a university, to correctly assess the students' disposition to study successfully and admit only those who will most likely complete their university studies.

There are two basic forms of study offered at universities in the Czech Republic.

Manuscript received November 30, 2021; revised December 22, 2021.

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Firstly, it is full-time studying, when the students attend lectures and seminars on a weekly basis during the lecture period of the semester. Students who have successfully finished their studies at secondary schools and continue with their education immediately at a university usually choose this form of study.

Secondly, it is part-time studying, when the students attend group consultations which usually take place once every two weeks during the semester, sometimes even less frequently. The frequency may also vary depending on the particular university and its specific faculty. This form of study is usually preferred by students who are already employed; they usually have to take care of their own families and they have to take personal time off work or, if the employer permits it, study leaves for the consultations.

The research of the students' study success in the first year at university was carried out at the Faculty of Transport Engineering, University of Pardubice in the Czech Republic (FTEUPCECZ). Faculty of Transport Engineering is a technical faculty and University of Pardubice is a regional university. The research took place between the years 2011 and 2020 and the sample used comprised 4,682 full-time and 2,282 full-time students.

A large group of courses taught at FTEUPCECZ requires students to already have basic knowledge of mathematics. Among other courses, students in the first year need to pass Mathematics 1 and Mathematics 2. These courses are connected in content and are taught during the first and second semester. They also belong to the subjects of the common core, which means they are obligatory for all students of the faculty. Students of both study forms consider these two courses to be very demanding and succeeding in them has a fundamental impact on the overall study success. Since the highest rate of failed examinations at FTEUPCECZ occurs in Mathematics 1, our research primarily focuses on this course and the way it is taught in both forms of study.

II. Literature Review

The research of the student success rate, especially in the first year at university, presents a complex topic. It is necessary to consider students' academic dispositions on the one hand and educational technologies on the other. The specialization of research on university education is currently growing significantly [1]. Individual research papers deal in detail with a limited, highly specialized research topic. Few studies focus on combining several different topics such as social background, mental health, stress and anxiety of

doi: 10.18178/ijiet.2022.12.6.1648

students on the one hand, and educational technologies, teaching methods, feedback and evaluation on the other. Through our research we try to contribute, at least in part, to closing this gap in the subject matters of published research papers.

The question of admission to university is an important aspect of the research dealing with the effectiveness of university education. This relates directly to the issue of tuition fees. Some schools do not charge fees, others do and the amount is determined by each school individually. Salas-Velasco [2] demonstrates a significant increase in the efficiency of public university education in Spain, following a previous change in the structure of the curricula and, in particular, a significant increase in tuition fees. Jones [3] focuses on university admission process in England after a sharp increase in tuition fees. He discusses the classic approach to admission based on understanding local conditions and allowing for social aspects of minority student groups to be considered. In addition, he mentions the current commercial trend within admissions influenced by the market and based solely on the results of the admission tests. Oldfield [4] notes that, despite very high tuition fees, students' active involvement in their education is low. The level of student absenteeism from classes is mainly influenced by their sense of belonging to the university, the subject of study, the personality of the teacher and the teaching methods.

The transition from secondary school to university represents a great change in a student's life. The integration into the university environment is a precondition for a successful transition, as is shown by research at universities in Germany [5]. The transition is impacted by psychological aspects such as self-confidence and conscientiousness of the students. Study success is mainly influenced by the students' own involvement [6], their interest in studying, and an appropriate choice of a future career. The results of the admission procedure, the subsequent drop-out rate and timely completion of studies are influenced by social conditions of students, as demonstrated in a study conducted in Italy [7]. Graduates of technical and vocational secondary schools are disadvantaged in comparison to graduates of secondary grammar schools. Students from areas with higher unemployment rates and poor labour market prospects lose motivation and reduce their active involvement in their education. Research carried out at the University of Cagliari in Sardinia [8] pointed to the influence of optimism and life satisfaction of students in their transition to higher education.

Students who enter the first year at university automatically assume that they have become university students. The reality, however, is more complicated. They are university students only formally. In terms of what it means, they are simply successful secondary school graduates, who are yet to become university students during the course of their studies. Some of them fail in this transformation and then they have to abandon their studies.

Students carry over their attitudes to studying from high schools into the first semester at university. Girls at high schools in Australia demonstrate in many ways a slightly higher motivation for studying than boys [9]. Jackson [10] discusses a research into the transition of high school students to selected universities in Northern England. He concludes that boys manage this transition better than girls. Another study [11] focusing on the transition of students from high school to university in Australia finds that a change in the attitude to studying is necessary and is related to a search for contentment. Brissette [12] discusses the impact of social network friendships in the United States in promoting increased optimism, reducing depression and student stress during their first semester of study.

Different attitudes to studying can be observed among students at universities. Their individual styles of studying are preconditioned by the students' own experience from the previous stages of their education at primary and high schools. Personality traits are also significant factors that influence the students' learning styles. Ashwin [13] discusses attitudes of students to higher education in the UK. He focuses on the different learning styles and the students' approach to studying, which are influenced, among other things, by the subject under study. The relationship between the teacher and the student is important, too. Alt [14] prefers a democratic and considerate approach of teachers to students, when the conflicts are resolved by dialogue, as opposed to authoritarian enforcement of power over students. This way, the teacher can significantly influence the relationship of the students to the course. Bovill [15] deals with the curriculum design and the concept of university education in Canada. He emphasizes the need for mutual respect, cooperation and understanding between teachers and students in the development of university curricula. Providing students with the opportunity to act independently and develop their confidence is the key to developing graduates' personalities and building their independence, which they will need to succeed in their future employment [16].

Study results are influenced by the anxiety of students and their positive and negative experiences with the course [17]. Shankland [18] discusses the academic burnout of students at universities in France. He discusses a research focused on students' mental health, anxiety, depression and hazardous behaviour related to everyday problems of students and their high work strain. The issue of students seeking psychological help at universities in the USA is examined by Komiya [19]. Nam [20] draws attention to gender differences between university students in South Korea when seeking professional psychological help.

Student satisfaction with their studies [21] is considered as an important motivating factor for studying and it is influenced by cognitive, creative and professional stimulation of the students. Bohndick [22] explores the relationship between a student's subjective abilities and subjective requirements and their impact on the student's success. Yin [23] carried out a research at 11 universities in China and concluded that study success is influenced primarily by the student's motivation and engagement.

Culver [24] deals with the issue of strictness in university education in the United States. He concludes that academic strictness has a positive impact on students' motivation to learn in their first year of study, especially for students with low motivation and a less positive attitude to learning. You [25] deals with the demanding and stressful university

environment in Korea. He concludes that academic stress does not have to be an exclusively negative factor, but in contrast, it can be a catalyst for the improvement of academic success rate.

An article by Bijsmans [26] focuses on the research of students' absence from seminars, lectures and consultations in bachelor studies at the University of Maastricht. Sloan [27] examined the absence of students in undergraduate education at British universities after 1992. According to him, the main factor influencing attendance is the motivation of students. Oldfield [28] investigated the causes of students' absence from classes at a particular British university. He states that a lower sense of belonging to the university, the number of hours of paid employment, the amount of social life commitments and mental health problems are the main factors of absenteeism. Aparicio-Chueca [29] deals with the absence of students from classes at the University of Barcelona. He mentions several factors influencing the absence: internal values of students, personalities of the teachers, teaching methodology, subject difficulty and available external study materials. Mearman [30] examines students' absenteeism in the first year at university and finds influence of alternative sources of information and low priority of classroom participation in students' personal hierarchy of values. The most important driver of higher attendance was the motivation of students.

Students' academic dispositions and educational technologies both affect the efficiency of education at universities. Currently, the majority of teachers use computers in some way in the process of education. If we leave out training in specialized courses such as applied statistics or programming, which takes place exclusively in computer labs, it is primarily the creation of study materials what they use computers for. Many teachers record their lectures and then provide the video recordings to the students by publishing them on computer networks of the faculties and universities, or they make these videos available to the public on the Internet without any restrictions.

Cabra [31] describes the involvement of students in Japan in the creation of multimedia learning aids that are stored on a university server and used for new student learning in subsequent years. Daenekindt and Huisman [32] focused on studying the use of mobile technology in education, particularly in Australia.

The teachers' concepts and approaches to computer-aided learning are crucial for successful implementation of new educational technologies in higher education [33]. Evans [34], of the University of Hong Kong, reports that online learning has become a ubiquitous part of the educational environment. Tummons [35], of the University of Canada, explored what ICT tools teachers and students use in their daily work. Wang [36] from Qingadao University, China draws attention to the possibility of technostress in connection with ICT-supported teaching.

Forsyth [37] from an Australian university notes that the growth of e-learning technologies has eliminated the boundaries between traditional and distance learning. Nieuwoudt [38] from Southern Cross University, Australia deals with the issue of creating courses for synchronous and asynchronous online education. Ellis [39] deals with students' perspective on e-learning. Literat [40] states that some teachers consider the massive spread of open online courses as a positive force in the expansion of educational opportunities, but others consider this trend as a threat to the current university education models and as a poor substitution for traditional learning. The issue of creating MOOC courses deals with, for example, Albó [41] from Spain or Rabin [42] from Israel. Chansanam [43] from Thailand highlights the importance of modern online learning systems for teaching especially during the Covid 19 pandemic.

Nordmann [44] deals with the influence of publishing lecture recordings on the attendance of students at lectures in their first year as well as later during their bachelor studies at a university in Scotland. He concludes that it is not possible to claim conclusively that publishing of lectures would adversely affect the attendance of students at lectures. By contrast, Edwards [45], based on a research conducted in England, notes that publishing recorded lectures hurts the students' attendance and states that watching lectures cannot replace attending a real lesson. Morris [46] describes experience with publishing video lectures at universities in England. Students accept this publication very positively, but lecturers point to a decrease in student attendance at courses. The teachers are also convinced that mere watching of the videos is not equivalent to active participation in classes. Dommett, van Tilburg, John [47] reached a similar conclusion. Additionally, they also ask the question whether the absence of students from classes should not be first authorized by the relevant department. Canadian authors [48] point out that many students do not spend enough time and do not pay enough attention to recorded lectures because they may go through an entire ninety-minute lecture in only five minutes. Moores [49] from England points to an evident connection between student attendance at courses and student success in their studies. Fritz [50] focused on using video recordings of lectures in part-time education at medical schools in the USA. One group of students was present at the lecture; the other group watched a video recording of the lecture. Students of both groups passed the final test. Nevertheless, the students who were present at the lecture achieved better results in the test. The authors of this paper believe that this fact is connected with the level of the students' study conscientiousness.

Sarsfield [51] examines publishing of lecture video recordings at London Imperial College and the impact it has on the effectiveness of teaching various subjects and in different years, on teaching of students with special needs, etc. Dommett, Gardner, Wiradonk [52] observe different views of students and teachers on video recorded lessons on the one hand, and benefits of video recordings for students with disabilities on the other hand. At the same time, they point out the lower authenticity of the lectures, because the lecturers are reluctant to use humor and jokes during the lessons.

From the above literature review, it is evident that the following key themes need to be addressed in our research. These are the admission procedure issues, student engagement in the transition from high school to university and teachers' support of students' ongoing active approach to

learning, the creation of new multimedia learning materials, including video recordings of lectures, and the impact of new learning materials on students' personal participation in the learning.

III. Research Part

A. Research Methodology

The success of students in first semester at university has a major impact on the overall success in their university studies. Therefore, this is an important issue for us and we have been looking into for a long time. In the past, we have tried to attract students who are genuinely interested in studying. That is why our faculty promotes our fields of study among students in secondary schools every year, not only through advertising, but also through active trips to secondary schools and motivational lectures. In addition, open days are held annually, where prospective students can learn about the fields of study offered and the faculty's facilities, including laboratory and semi-operational equipment.

Good promotion of the faculty has a positive effect on students' interest in studying at the faculty. In our research, we focused on tracking the number of students who enrol at university. This number of students is closely related to the population curve and therefore to the number of high school graduates.

Our research has focused on the subject of Mathematics 1, as it has long been the subject with the lowest success rate of the students in the first semester.

We did measure not only the overall success rate of students, but we were also interested in student engagement in the learning, which could be monitored and compared over the long term in terms of full-time students' participation in Mathematics 1 seminars.

In an effort to encourage student activity during the semester, we allowed students to write credit tests in the course of semester. As a part of the research, we then monitored the impact of this measure on students' credit pass rates.

In agreement with the development of e-learning, multimedia study materials Mathematics 1 [53] and collection of problems Mathematics 1 [54] have been created. They contain both printed part and attached DVD. Subsequently, video recordings of actual lectures from Mathematics 1 were published. Within the research, we were interested in the use of different forms of study materials by both full-time and part-time students. We also addressed the question of whether the use of different forms of study materials has an impact on students' exam success. We conducted the research using questionnaires distributed to students after the end of the first semester. We have conducted similar research in previous years. This allowed us to optimize and refine the composition of each question in our questionnaire, which we present in this paper.

At the end of our research, we investigated the association of students' exam performance with their personal participation in lectures and seminars. We also investigated the effect of modern multimedia study materials and published video recordings of lectures on students' personal participation in lectures and exams.

B. Success Rate of Students in the First Year of University Studies

Fig. 1 shows the number of students admitted to the FTEUPCECZ in recent years, both in full-time and part-time forms of study. The chart also shows the development of the number of students who successfully completed their secondary school studies in these years and were entitled to study at universities. It follows from the chart that the trends which occur in the population curve have had a significant impact on the number of admitted students, especially in the full-time form.

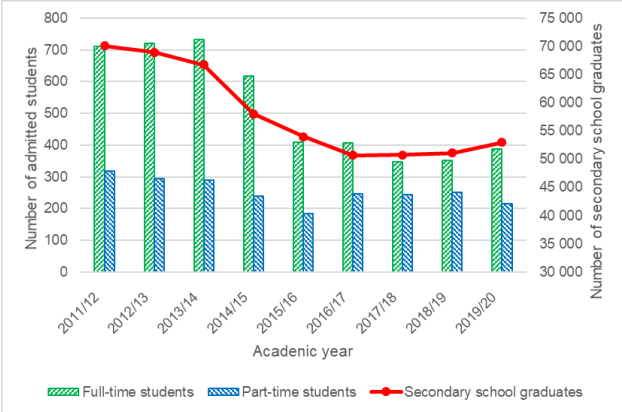

Fig. 1. Number of secondary school graduates and number of admitted students.

A long-term prevailing conviction among the students is that the greatest difficulties in the first year of study are courses Mathematics 1 in the first semester followed by Mathematics 2 and Algorithm development and programming in the second semester. Indeed, the highest decrease in the number of students occurs after the first semester. To specify, 344 full-time and 192 part-time students were enrolled in the first semester in the academic year 2019-2020. Only students who obtain at least 15 credits (The ECTS, European Credit Transfer System) in the first semester can continue to the second semester. The standard plan is 30 credits per semester. Only 146 (42.4%) full-time students and 95 part-time students (49.5%) qualified to continue to the second semester in the academic year 2019-2020.

A questionnaire research was carried out among the full-time students at the beginning of the second semester. Among other things, students evaluated courses according to popularity and difficulty. Out of 157 distributed questionnaires, 116 were filled out and returned. The course Mathematics 1 was identified as the most difficult one by 60% of the students. This is in line with the fact that Mathematics 1 has the highest long-term failure rate of all courses. Therefore, our research focuses on this course.

Figs. 2 and 3 show how the numbers of full-time and part-time students enrolled in Mathematics 1 have changed over the recent years.

To understand the individual parts of the charts in Figs. 2 and 3, it is necessary to explain the process of admission to universities in the Czech Republic and the specific method of teaching Mathematics 1 at FTEUPCECZ.

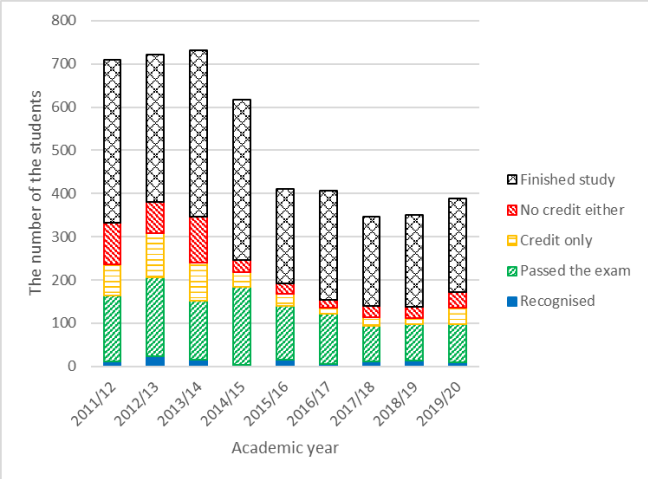

Fig. 2. Number of full-time students.

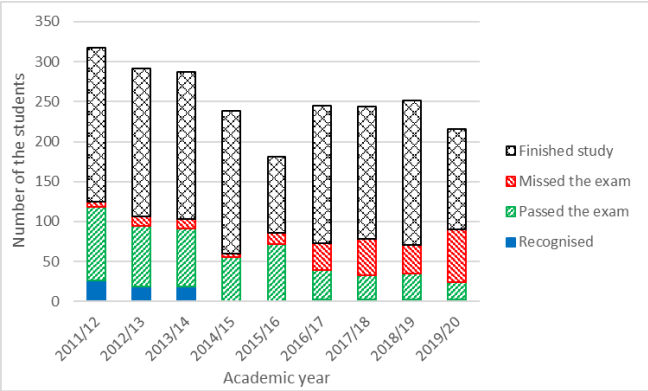

Fig. 3. Number of part-time students.

C. The Faculty Admission Procedure

Technical education in the Czech Republic is currently going through a major crisis. There is little interest in studying technical branches on all levels of education from apprenticeships and vocational secondary schools to technical faculties of universities. Consequently, this fact has an impact on the admission procedures for these technical faculties.

Only applicants who have completed their previous secondary school studies by passing the school-leaving examination may apply to study at universities in the Czech Republic. After passing this examination, they receive the school-leaving certificate, which is proof of completion. This is the final examination similar to the British "A-level exams", the German "Abitur" or the French "Le baccalauréat".

Students who wish to study at the FTEUPCECZ must submit the school report from the last year of secondary school and the school-leaving certificate. The level of education at secondary schools in the Czech Republic varies. This is evident especially in the level of mathematical knowledge. If the faculty admission procedure included a test in mathematics, secondary school graduates who, not by their fault, received less instruction in mathematics in their previous studies would be automatically excluded. Therefore, the admission procedure does not contain any specialized tests. Students are admitted based on their school reports and students who have successfully passed an optional mathematics test as part of their school-leaving examination are given priority. Overall, this form of admission procedure makes it possible to study at the faculty also for students who took fewer lessons in mathematics at their secondary schools. However, these students have to fill their knowledge gaps during the first semester by self-studying.

At the same time, students who have never really wanted to study are also enrolled. The situation is similar at other faculties in the Czech Republic, especially the technical ones. By enrolling at a university, students gain an undergraduate status which gives them many benefits. Until the age of 26, their health and social insurance are covered by the state, they are entitled to reduced fares on buses and trains, they can also apply for accommodation benefits, etc. These students abuse the national social policy and distort the statistics of study success in the first year at universities.

D. Studying the Course Mathematics 1

If the students in the full-time study form want to successfully complete Mathematics 1 at FTEUPCECZ, they must first receive the so-called course credit, which is awarded upon passing a written pre-exam test. Each student has three attempts to pass the test. After receiving the credit, the students proceed to the examination, which consists of a written and oral part. Part-time students do not take the pre-exam test but take the examination directly. Students who can provide evidence of successfully completing a similar course at another faculty or university no later than three years ago and with a grade A to C, may apply for a transfer of the course. Examinations older than three years or with grades worse than C are not accepted.

Fig. 4 shows the overall analysis of student success in the course Mathematics 1 in the last academic year 2018-2020. At the beginning of the semester, 351 full-time students were enrolled. The chart shows that only about one-quarter of the enrolled students successfully completed the course. Students who abandoned their studies represent the largest portion of the chart. The statistical data are distorted by the fact that approximately one-third of the students who enrolled at the beginning of the semester never started their studies and never appeared at the faculty except for the enrollment procedure, which has to be done in person. They only abused social benefits, formally increased the failure rate, and formally reduced the effectiveness of teaching in the first year at the faculty.

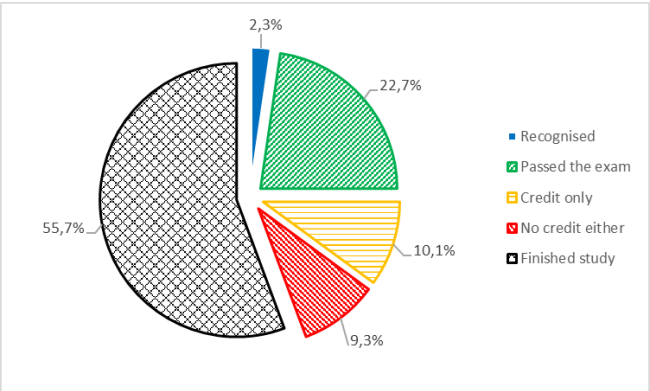

Fig. 4. Exam success rate of full-time students in the academic year 2018-2020.

Fig. 5 illustrates the success rate of part-time students in the academic year 2018-2020. Because part-time students attend only lectures, where attendance is not recorded, it is

not possible to determine how many students abandoned their studies because they never wanted to study, and how many quit due to actual study failure.

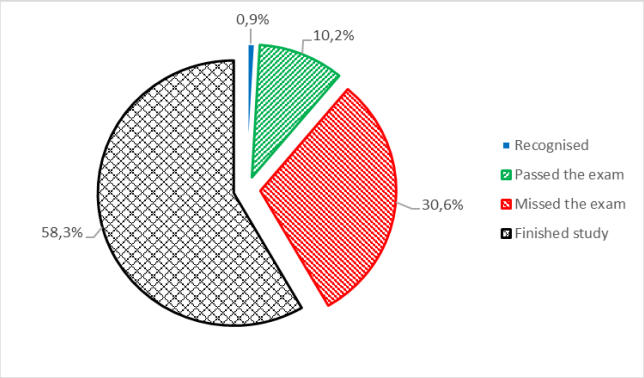

Fig. 5. Exam success rate of part-time students in the academic year 2018-2020.

Besides job commitments and family responsibilities, the time gap between their previous secondary school and entering the university also has a negative impact on the part-time students' success. In the academic year 2018-2020, 277 students were surveyed. On average, 6.9 years (standard deviation of 6.8) have passed since the students' school leaving examination.

E. Attendance of Students at Lectures and Seminars and Pre-exam Test Success Rate

The attendance of students at lectures is voluntary in both forms of study and is not monitored. The attendance of full-time students at seminars is also voluntary but it is recorded. The resulting overview of full-time students' attendance over the previous four academic years is shown in Fig. 6. The chart shows that the highest attendance at seminars occurred in the first two weeks of the semester when it ranged from 70 to 80%. It can also be seen that almost one-quarter of full-time students enrolled in Mathematics 1 never attended the seminars. In the current academic year (2019-20), there was a further decrease in attendance, when 40% of enrolled students did not attend seminars already in the first week of the semester. Overall, we can observe a gradual decrease in student attendance at seminars. The growth in the 8th week is related to the fact that students had the first opportunity to pass the pre-exam test. The following decrease in attendance results from the fact that some students who had failed the first test attempt decided to abandon their studies.

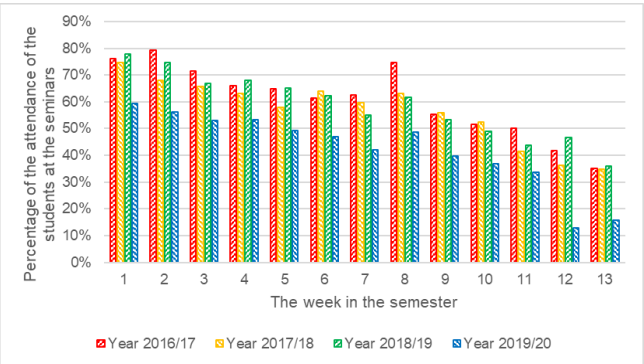

Fig. 6. Attendance of full-time students at seminars.

For fluent transition from high school to university and for increasing of student engagement and support their ongoing studies, we have allowed to students to take the credit tests in any of three attempts. The first one was held in the 8th week of the semester, when the credit test contained subject matter of only the first half of the semester and was therefore the easiest. The second one was during the 12th week of the semester, when the credit test contained subject matter from three fourth of the entire semester. The third one was in the exam period and the credit test contained subject matter of the whole semester and was, therefore, the most difficult.

The overall success rate of full-time students at the pre-exam test after the first, second, and third attempts in recent years is shown in Fig. 7. Thus, it may be stated that the overall success rate after the third attempt is approximately between 30 and 40%. It should still be remembered that the statistics are distorted by students who never wanted to study. However, their exact number cannot be ascertained, because attendance at lectures and seminars was voluntary.

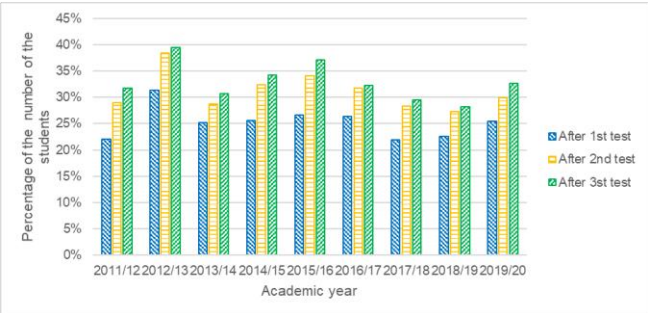

Fig. 7. The success rate of full-time students at the credit test.

F. Educational Technologies

Mathematics 1 in the full-time form of study is taught in the extent of 3 hours of lectures and two 2-hour long seminars per week. The semester is 13 weeks long. Students may also attend an optional mathematics seminar of 2 hours per week. The Mathematics Seminar is a form of remedial tutoring, designed especially for students who received less mathematics instruction during their secondary school studies and have some difficulty with the study of mathematics. In addition, each teacher offers individual consultations at the request of students.

The instruction in the course Mathematics 1 in the part-time form of study is organized into 22 hours of lectures per semester. Students also have the opportunity to attend the Mathematical Seminar in the extent of 12 h per semester.

G. Study Materials

In the past, there were two types of printed study materials. The basic textbook was theoretical and contained all necessary mathematical definitions, theorems and formulas, which were supplemented by written explanations. In addition to that, printed collections of solved and unsolved exercises were available. These printed materials are still available for students.

Since 2013, students have the opportunity to study using a recently published multimedia textbook consisting of a printed workbook and an accompanying DVD. The printed workbook contains all the theoretical concepts, i.e. definitions, theorems, formulas and only basic commentary.

It serves as a kind of a notebook, which students can bring to both lectures and seminars so that they do not have to write down the relevant mathematical definitions, theorems and formulas. This prevents unnecessary typing errors, students can fully concentrate on the lecture or presentation and can write down their own additional notes in their workbooks. The accompanying DVD contains the basic text, which is identical to the printed version, and supplements it by video recordings of real lectures from previous years. This way students have the opportunity to replay videos of selected parts of the lectures repeatedly, which allows for a better understanding of the topic. Also, students who, for any reason, are unable to attend a given lecture can watch the lecture later at a place and time that suits them best.

Based on the positive feedback of students on the Mathematics 1 multimedia textbook, a multimedia collection of mathematical problems and exercises was also created. It also consists of a printed part and an accompanying DVD. The printed part contains specifications of the theoretical questions and tasks and instructions for the problems. The DVD contains the specifications of the theoretical questions and tasks too plus corresponding answers. It also contains video recordings of solved problems and additional unsolved problems for practicing. Furthermore, practical mathematical problems and exercises focusing on various disciplines taught at the faculty are given in each chapter. All these problems are solved and students can watch the corresponding videos showing their solutions. These problems are motivational and show students the importance of mathematics for successful study of other follow-up courses.

Multimedia study materials received positive feedback from students. For this reason, it was decided to start publishing video recordings of current lectures. Video recordings are always available on the faculty computer network the day after the lecture.

Apart from these multimedia study materials, students also have the opportunity to study from traditional printed materials published by our colleagues for a similar subject at FTEUPCECZ. Because basic mathematics courses are taught in a similar way at technical faculties of other universities, students can study from materials published by these faculties as well. Many students also search for additional study resources on the Internet. Some of them pay for private tutoring.

Students who received less mathematics instruction at their secondary schools must review secondary school mathematics themselves. For this purpose, our faculty organizes a preparatory mathematics course, which takes place before the beginning of the first semester. It is expected that students also review mathematics from their own notes they have from secondary schools or other study resources focusing on secondary school mathematics.

H. What Study Materials do Students Prefer?

To describe all study strategies used by students in the first year of studying Mathematics 1, we conducted a questionnaire survey among the students. The questionnaires were distributed to students who attended the first lecture of Mathematics 2 in the summer semester. These students were therefore students who had completed their studies in the first semester. They obtained at least 15 credits and continued with their studies. Seventy-four full-time students and thirty-seven part-time students participated in the research.

The research aimed to find out which study materials were used the most by the students in the full-time form of study, and which in the part-time form. We also wanted to see whether there was a difference in the use of the study materials between students who successfully passed the examination in Mathematics 1 and students who did not.

Fig. 8 compares the use of various study materials, in percent, by full-time students depending on their passing (39 students) or not passing (35 students) the examination in Mathematics 1. The p-value of the Wilcoxon sum rank test was used to assess the statistical significance of the results obtained.

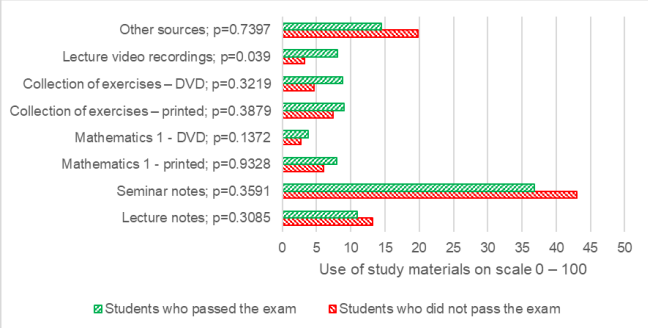

Fig. 8. Use of study materials by full-time students.

The chart shows that students used mainly their own notes from lectures and especially from seminars. In both cases, however, there was no statistically significant difference between the two groups of observed students. Another important source of information for the students were study materials from other faculties and universities which are freely accessible on the Internet. A somewhat surprising finding regarding the use of video recordings of lectures was that the students preferred the complete hour-long video recordings of current lectures over the edited and thematically arranged video recordings of lectures from previous years which are part of the multimedia Mathematics 1 textbook. In the case of the lecture video recordings, there was a statistically significant difference in the use of this study material between the groups of students who were successful and unsuccessful in the examination. Fig. 8 shows that a greater use of this study material leads to a higher probability of passing the examination.

Fig. 9 shows a comparison of the study materials use, in percent, for part-time students depending on their passing (16 students) or not passing (21 students) the examination in Mathematics 1. The p-value of the Wilcoxon sum rank test was again used to assess the statistical significance of the results obtained.

The chart in Fig. 9 shows that students the most widely used exam preparation tool was the Collection of exercises from Mathematics 1. The e-book was slightly preferred before the print version.

The chart in Fig. 9 shows that the most widely used exam preparation tool was the Collection of exercises from Mathematics 1, both the printed part and the accompanying

multimedia DVD. The figure also shows that the higher use of this study material leads to a higher exam success rate. This fact, however, could not be confirmed by the chosen statistical test. The test shows a statistically significant difference between the groups of students who passed or failed the examination in Mathematics 1 only with respect to the use of Mathematics 1 textbook, which includes the theoretical foundations for the course. It is interesting to note that the textbook was used more by students who did not succeed in the examination. The authors believe that focusing on the theoretical foundations leads to underestimating the practical part (calculating and solving problems), which results in failing the examination.

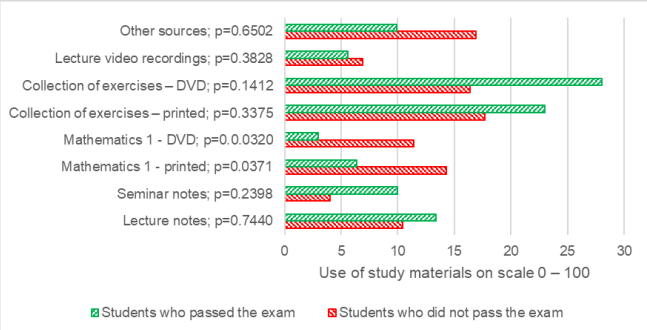

Fig. 9. Use of study materials by part-time students.

Fig. 10 shows the overall comparison of the study materials use by students in both forms of study, regardless of their examination results.

The chart shows that full-time students used their own notes from seminars the most. Part-time students used the multimedia part of the Collection of exercises from Mathematics 1 the most. In both cases, there are statistically significant differences between the individual groups. Other statistically significant differences in the use of the individual study materials between full-time and part-time students were observed also for the text part of the Collection of exercises from Mathematics 1 and lecture video recordings.

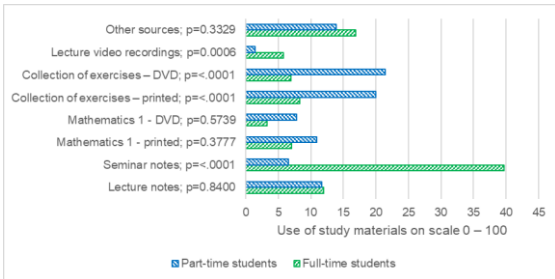

Fig. 10. Using of study materials by students of both forms of education.

I. What Is the Connection between the Study Success and the Attendance of Students at Lectures and Seminars?

Another important question we dealt with in the research was whether the attendance of students at lectures and seminars decisively determined their success in the examination. The answer to this question was also obtained from the questionnaire survey mentioned above. The students answered the questions "What was your attendance at lectures?" (UCSTP) and "What was your attendance at seminars" (UCSTC) on the scale 0 - 100. The results are presented in Tables I and II.

Table I shows that full-time students who passed the examination have a statistically significantly higher attendance rate at lectures than students who failed. The difference in seminar attendance between successful and unsuccessful students could not be proved.

Therefore, it is evident from the table above that full-time students who underestimate the attendance at lectures and pay little attention to theoretical mathematical instruction have a great difficulty with meeting the conditions to pass the examination. In their case, the absence is unfounded because they are full-time students and therefore nothing should prevent them from attending the lectures.

It can be seen from Table II that there are no statistically significant differences in the attendance rate at lectures and seminars between the groups of successful and unsuccessful part-time students.

TABLE I: WILCOXON SUM RANK TEST FOR UCST (FULL-TIME STUDENTS) - GROUPED BY PASSED OR FAILED EXAMINATION

Variable	Group	n	Mean (Std)	Median	Q1, Q3	Min, Max	p-value*
UCSTP	P	39	69.3 (29.92)	80.0	50, 95	10, 100	0.0278
	F	35	52.3 (34.63)	60.0	10, 80	0, 100	
UCSTC	P	39	90.8 (10.92)	95.0	90, 100	50, 100	0.7015
	F	35	92.9 (6.67)	95.0	90, 100	80, 100	

Std - Standard deviation, Q1 - Lower quartile, Q3 - Upper quartile, F - failed exam, P - passed exam.
* p-value of Wilcoxon signed rank test for dependent samples

TABLE II: WILCOXON SUM RANK TEST FOR UCST (STUDENTS IN PART-TIME FORM OF STUDY) - GROUPED BY PASSED OR FAILED EXAM

Variable	Group	n	Mean (Std)	Median	Q1, Q3	Min, Max	p-value*
UCSTP	P	16	65.0 (42.07)	85.0	18, 100	0, 100	0.1157
	M	21	86.4 (26.04)	100.0	90, 100	0, 100	
UCSTC	P	16	43.1 (50.56)	0.0	0, 100	0, 100	0.4255
	M	17	32.4 (45.49)	0.0	0, 80	0, 100	

Std - Standard deviation, Q1 - Lower quartile, Q3 - Upper quartile, F - failed exam, P - passed exam. * p-value of Wilcoxon sum-rank test

This different result, when compared to full-time students, may be a consequence of a smaller number of lessons (22 hours of lectures + 12 hours of seminars per semester) in comparison with full-time students (39 hours of lectures + 52 hours of seminars per semester). As a result, the source of information for part-time students shifts to the printed and multimedia study materials, as shown in Fig. 9.

J. What Is the Effect of Publishing Video Recordings of Lectures on the Attendance of Students?

To answer this question, students of both forms of study were asked two partial questions. "If video recordings of

lectures were not published, what would your attendance at lectures (TUCSTP) be and what would your attendance at seminars (TUCSTC) be?" The obtained data were compared with the answers to the questions "What was your attendance at lectures?" (UCSTP) and "What was your attendance at seminars" (UCSTC). The results are presented in Tables III and IV.

Table III shows that in the case of full-time students, if the video recordings were not available, the attendance at lectures would increase statistically significantly. The difference in attendance at seminars is statistically insignificant.

As demonstrated in Table IV, as observed in the case of full-time students, also in the case of part-time students there is a statistically significant difference between real attendance at lectures, and hypothetical attendance at lectures if the video recordings were not published. The difference in seminar attendance is inconclusive.

TABLE III: DIFFERENCES BETWEEN UCSTP/TUCSTP AND UCSTC/TUCSTC (FULL-TIME STUDENTS)

Variable	n	Mean (Std)	Median	Q1, Q3	Min, Max	p-value*
TUCSTP	74	70.3 (29.24)	80.0	50, 95	0, 100	
UCSTP	74	61.3 (33.13)	65.0	30, 95	0, 100	
TUCSTP - UCSTP	74	9.0 (19.43)	0.0	0, 10	-20, 80	<.0001
TUCSTC	74	92.0 (10.92)	95.0	90, 100	40, 100	
UCSTC	74	91.8 (9.16)	95.0	90, 100	50, 100	
TUCSTC - UCSTC	74	0.2 (7.79)	0.0	0, 0	-50, 23	0.2559

Std - Standard deviation, Q1 - Lower quartile, Q3 - Upper quartile. * p-value of Wilcoxon signed rank test for dependent samples

TABLE IV: DIFFERENCES BETWEEN UCSTP/TUCSTP AND UCSTC/TUCSTC (PART-TIME STUDENTS)

Variable	n	Mean (Std)	Median	Q1, Q3	Min, Max	p-value*
TUCSTP	37	83.9 (28.75)	100.0	80, 100	0, 100	
UCSTP	37	77.2 (35.07)	100.0	60, 100	0, 100	
TUCSTP - UCSTP	37	6.8 (15.86)	0.0	0, 0	-10, 50	0.0156
TUCSTC	32	45.0 (49.45)	0.0	0, 100	0, 100	
UCSTC	33	37.6 (47.57)	0.0	0, 100	0, 100	
TUCSTC - UCSTC	32	6.3 (19.80)	0.0	0, 0	0, 100	0.0625

Std - Standard deviation, Q1 - Lower quartile, Q3 - Upper quartile. * p-value of Wilcoxon signed rank test for dependent samples

IV. CONCLUSION

The admission procedure for FTEUPCECZ does not discriminate anyone, there are no tuition fees and the faculty admits all successful secondary school graduates without checking their actual mathematical knowledge. Thus, the faculty accepts also to students who, not by their fault, had the less mathematics instruction at their secondary schools. Foreign students who have successfully passed an examination in Czech are also accepted to study in the Czech language.

However, there is a relatively large group of students who enroll at the faculty only to gain the legal status of a university student. This brings them a number of social and economic benefits because the state covers their social and health insurance, they receive discounts on train and bus fares and they can apply for accommodation scholarships, etc. These students are abusing the national social benefits system and it is a matter of discussion whether a certain form of tuition fees could eliminate such abuse.

The research leads to the conclusion that full-time students who underestimate the attendance at lectures subsequently have problems to pass the Mathematics 1 examination. These students want to learn only specific algorithms to solve certain problems without understanding theoretical fundamentals of mathematics these algorithms are based on. Such students are not willing to take charge of their own development in mathematics, they do not want to gain logical-mathematical thinking, they are not interested in understanding the connections between particular mathematical facts and, consequently, they are not able to generalize the acquired knowledge. They think that it will be enough for them to go through a training merely in solving particular tasks used in the examination. They are then unable to compensate for the shortcomings from the theoretical part of the course by good attendance at seminars.

Part-time students prefer to attend lectures over participating in the Mathematical Seminar. These students try to minimize their personal attendance at lessons because of other personal commitments. They believe that, in order to study successfully, it is sufficient for them to attend the lectures, where they get acquainted with the necessary theoretical fundamentals of mathematics and with certain selected problems. By not attending the Mathematical Seminar, they deprive themselves of the opportunity to become familiar with solutions to many other problems, which could be used in different variants in examination tests. The missing knowledge and skills must then be compensated by self-studying from the provided study materials. Some of the students also pay for private tutoring.

There is a considerable difference between full-time and part-time students in which study materials they use the most. Full-time students focus mainly on their own notes from lectures and especially from seminars. Their use of video recordings is relatively low in the case of both current and edited recordings from previous years, which are part of the multimedia textbook Mathematics 1. On the other hand, part-time students prefer all available multimedia study materials over their notes from lectures and seminars.

Students of both forms of study admit that the publication of video recordings of lectures leads to a certain decrease in attendance at lessons. This difference is statistically significant only for full-time students and only regarding their attendance at lectures. In the other cases, a decrease in

the attendance of students was recorded, but it was statistically insignificant.

In conclusion, we can say that the effectiveness of teaching students in the first semester is significantly influenced by the approach of the individual groups of students to studying. The publication of video recordings of lectures has a certain negative impact on the attendance of students, but it is beneficial for the vast majority of them. It is important especially for part-time students, who use the published video recordings of lectures and the theoretical part as well as the collection of solved and unsolved exercises in the multimedia textbooks the most.

In the future, we would like to extend the research to include the teaching of mathematics in the second semester, focusing in particular on courses Mathematics 2 and Algorithmizing and Programming, because these courses were identified by students as the most difficult ones in the second semester. It will be necessary to monitor the development of the students during their first year at the faculty and changes in their attitudes to studying.

Conflict of Interest

The authors declared no potential conflicts of interest concerning the research, authorship, and publication of this article.

Author Contributions

JK, VJ, and OS conducted the research, wrote the paper and analyzed the data; all authors had approved the final version.

Acknowledgment

This research was supported by the Faculty of Transport Engineering, University of Pardubice.

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