QUANTIFICATION OF EDUCATIONAL PROCESS PARAMETERS USING NEW TECHNOLOGIES

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Abstract: One of the criteria for a student's acceptance into our university is his/her success in the entrance testing. The aim of this work was to create a model for measuring the effectiveness of the pedagogical process using IT support. Utilising the mentioned model we hope to create an educational system aimed at the reduction of disparity in educational habits and skills from the chosen areas of economic studies targeting quantitative methods. The entry test is needed for the subjects of mathematics as well as economics and foreign languages. In this article we have proven that there exists a correlation between the entrance test results and the evaluation results in the subject of mathematics for the winter semester of the first year of the bachelor studies

Keywords: model, Blended learning, teaching, effectiveness, mathematics,education

1 Introduction

Universities are also influenced by new trends in education. The content and type of subjects are ever changing and adjusting to the demands of the students and the companies which are perspective employers of the graduates. Education is a complex process representing more than just a change of information between the teacher and the student. Measurement of added value in education has recently become a sought-after tool for quantitative assessment of educational institutions. The added value expresses a degree of knowledge that a student has acquired over a period of time by actively participating in the teaching process of that educational institution. The quality of education determined by this method is quite often discussed (Harris 2011, Krpec and Burda, 2011, Mura 2017, Radu 2018, Anyakoha 2018, Kaclík et al. 2015). The measurement of added value consists in the fact that before and after completing the educational process, the knowledge of the given student, respectively. groups of students in a suitable form of test, the content of which corresponds adequately to the curriculum. The results obtained are then compared and evaluated on the basis of a statistical model. The desired conclusion is the information indicating the "scope" of newly acquired knowledge (Braun 2005, Rogers et al. 2011,Buleca 2014). The continual monitoring of various parameters of the process (using more or less sophisticated models and/or using IT systems) is currently a normal part of the management support in many organisations. With its help it is possible to discover critical places in the processes and subsequently to take measures to eliminate its negative influence. A similar situation exists in the educational process as well. In today's information loaded era of addiction to computers and the internet it is necessary to adjust the educational process so the student is able use his/her knowledge without any problems in everyday practice. The use of computers, mobile phones or other technologies is taken as a matter of course by the younger generation. Applications like Facebook, Viber or Whatsapp are considered a commonplace communication channel. But the companies require something more from their employees (Žulová,2018). They have to be able to search and manage the information in the shortest time possible, so they have to navigate around the internet quickly and effectively. They have to present their results and they have to work in teams which implies learning the job division and responsibility for the other members of the team. One of the possibilities for how to prepare a student for managing real life situations is to include informative technologies in the syllabus. The advantages of a computer supported syllabus (Bajtoš, 2006; Híc & Pokorný, 2004; Turek 1996):

Studying at one's own pace
Chance to offer immediate feedback
Option to go over the same materials and exercises many times according to one's need
Mistake notification. A student feels psychologically less offended when during their learning process the mistake notification comes from a computer programme than from a teacher or a classmate
Objectivity of grading

It is notable that the use of technology in the education process does not guarantee the success of it per se. It is necessary to find the right extent and the best way of incorporating these technologies.

It is also important to understand that upon entry into the university the students do not have great skills in the use of informative technologies for their self-education and the internet is more the means of fun and relaxation for them.

One of the basic methods utilised in the educational process is e-learning. The new e-learning software products allow the monitoring of the individual phases of student's learning on an individual level. They enable interactive testing of his/her skills and knowledge. With appropriate models it is subsequently possible to design such educational processes which can help the student in the most effective way to understand the explained part of syllabus. There are significant differences observed in the readiness of the applicants of various technical and economic universities (Rozsa,2018). Different departments have noticed a decreasing trend in exam results in the field of mathematics. Regarding the area of quantification methods, scientific and technical developments as well as the current developments in economics have resulted in increasingly higher demands on a university student's knowledge. The number of lessons in mathematics or informatics (or other quantitatively oriented subjects respectively) differ in various types of secondary schools.

E-learning represents a method of education, or propagation of information, via informative technologies. At the same time it offers a database of information in the form of educational materials available through this learning. It can have several forms and thus can be tailored to the individual needs of the student, groups and organisations. The most acclaimed type of e-learning is the so-called asynchronous e-learning. It includes the self-study of the students who can choose what information, when, and at what pace they are going to receive it. The student adjusts the learning process to his/her needs and habits. Horton defines e-learning as the means of using the electronic technologies to acquire educational experience, i.e. how is this experience formed, organised and created. Graham sees the main advantage of e-learning and the expected benefit being based on the greater accessibility of information considering two aspects (time and space). E-learning is education enabling free and unlimited access to information. Blended learning is a special form of education combining the presentative form of teaching with the electronic and web applications, mostly e-learning with the aim to suppress its negatives and to reach a synergy of benefits from both approaches. Blended learning is the subjects of many recent scientific works (Garrison & Kanuka, 2004; Schroeder & Oakley, 2005; Dziuban et al., 2004; Osguthorpe & Graham, 2003; Graham, 2006; Eger, 2005; Lewis et al., 2006). Graham (2012) presents the existing models of blended learning and discuses the importance and usefulness of BL for the present and future. He states three reasons why people use to choose this method: To improve pedagogy, Easy access and a high degree of flexibility,Cost effectiveness.

2 Empirical background

This experiment was inspired by several things. The first was the results of the entrance exams for the academic year 2017/2018.

Compared to the previous year the students worsened by 2.25 points which could be reflected on the quality of our subject (mathematics). Our decision was not to submit and decrease the demands of the subject which would lead to a decrease in quality in other subjects. Because this subject was taught by two teachers it is not possible to devote individual attention to every student in a way corresponding to his/her needs and knowledge. That means that when we wanted to add new methods into the syllabus we had to consider not only the quality of education but the demand on time from the teacher's perspective.

A mentioned earlier, the analysed subject is taught in the first semester of the first year. It means that the students do not have enough time to create groups where they can work together and help each other. The majority of students are still strangers to one another and the process of adaptation can take up to several weeks so the student is left to his/her own devices, at least in the beginning.

The other reason for this experiment was to prepare the students for their further studies and job practice. During the studies at our faculty the students are required to participate in various projects - they have to be able to choose partners, divide tasks, prepare the time and work schedule, research the necessary information, present their results and also carry the responsibility for themselves and other members of the team.

The first phase was focused on the secondary school mathematic skills observed within the entrance exam and mathematics itself. From this phase we can already evaluate the first results of our work. We worked with two groups of students where we monitored and compared their results from the entrance exam and subsequently from the subject of Mathematics listed in the first semester of the first year of the bachelor studies. To obtain the most accurate results we considered only the students who qualified with these two conditions: firstly they underwent the entrance exam in that academic year and became our students. Secondly, they had participated in the subjects during the whole length of the semester. We disregarded the students' evaluations who were at the entrance exam but did not become students of our faculty. That is the reason the students' numbers in the further data analysis are the same. The students entering our faculty had different levels of knowledge at the beginning of their study. The first group of students was tested as to whether the level of their knowledge from the entrance exam was directly connected to their results in the subject of Mathematics. It was the entrance exam for the academic year 2016/2017 and the subject Mathematics was taught during the winter semester of that year. The second group of students underwent the same testing but in the academic year 2017/2018.

3 Metodology

To help the students reach the required performance we decided to employ certain innovative methods using mostly computer support this academic year. At the first lesson of the class the students were divided into teams. Formation of the team was within the competence of the teacher and the main objective was heterogeneity. Every team consisted of students who were stronger and weaker in mathematics, according to their entrance exam results. Then a course was created in the environment Moodle, enabling the communication between the teacher and each student at the same time and also between the students themselves. The first step towards better results was the student's 'self-testing'. Beginning with the second lesson of the semester, every student was weekly given a series of tasks to solve, pertaining to the week's lesson. After marking the correct answer the student could continue with another task. Marking the incorrect answer lead to 'penalty tasks' aimed at practicing the problem more. The student was able to educate himself/herself at home without any time stress. At the same moment, the teacher got feedback about which tasks were causing the most problems and thus enabling a better choice for further lessons.

We also employed the teams differently. Every team was regularly given a certain task. They always had two weeks for it. The subject Mathematics had two 45min lessons a week for a period of thirteen weeks (so-called 'lab classes'). This was extended by two additional 45min lessons in the form of a lecture every week. All students were there together and there they presented their results. The teacher's responsibility was to evaluate and grade the work and to intervene only in case the students could not help themselves. The tasks were of various natures. Some focused on expanding the lesson, some were an example from real life or to practice the problematic areas learning. The third compulsory part was to solve a certain number of mathematical sums. Their amount varied according to the difficulty of the topic - sometimes it was only two or three. Considering there were 124 students, the acquired database of tasks per each topic was significant. On top of that, under the teacher's supervision, they were able to discuss it with the author of the solution about his/her used procedure, to point out the mistakes or to suggest a different solution and also to ask the teacher for help.

4 Data analysis and results

The students come to our faculty from various schools and towns. Most of them have graduated from secondary school that year but there are some who graduated several years before. Trade academies (a type of secondary school) do not even require a final exam in the subject of mathematics. All of this contributes to the different starting level for each student, which can be an advantage or disadvantage for his/her further study. In the first part of our research we deal with the question of whether there is a connection between the results of the entrance exam from Mathematics to the results of the subject during the first semester. In both cases (the entrance exam and the final semester evaluation) a student could receive 14 points. We monitored seven criteria awarded them with 0, 1 or 2 points. If a student received 0 points it meant that he/she did not meet the required expectation. The acquisition of 1 point meant that he/she did meet them and 2 points represented overachieving success, managing the problem to its full extent. This point system also corresponds with the demands of the accreditation of our faculty and is included within the system of international accreditation AACSB. AACSB's View of International Accreditation is that faculties with an economic and managerial focus voluntarily determine entry into the process. As a result of this voluntary process, obtaining AACSB International Accreditation is an important public statement that their leadership, educators, staff and students have decided to be responsible for the above expectations. They publicly express their willingness to undergo continuous self-evaluation and an external review process. Basically, they declare their intentions to use this process to ensure continuous improvement, quality and appropriateness of the teaching methods used.
There were 131 students participating in this analysis, all of whom underwent the entrance exam and also studied Mathematics in the academic year 2016/2017. The results are stated in Table 1.

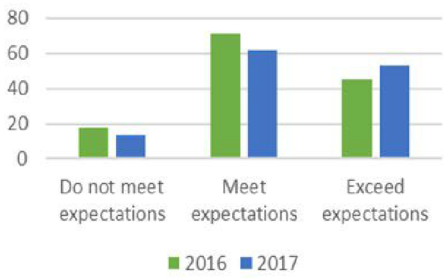
Table 1. Descriptive statistical indicators of continuous performance for the year 2016

	Entrance exam	Mathematics 2016
Sample size	131	131
Mean	7,40	8,08
Standard error	0,252	0,283
Median	8,00	7,00
Mode	7	7
Standard deviation	2,884	3,239
Variance	8,320	10,493
Skewness	-0,575	-0,508
Kurtosis	0,935	0,419
Range	14	14
Minimum	0	0
Maximum	14	14

Source: own processing

We decided to adjust our usual teaching methods based on the above-mentioned analysis and the fact that the point average for the entrance exams of 2017/2018 was 5.15 point, which represented 36.8%. In that academic year we evaluated 124 students and the results are stated in Table 4 and Fig. 1.

Figure 1. Results from Mathematics for the years 2016 and 2017



Source: own processing

Table 2. Chi-square test of independence – The comparison of the total continuous performance for the year 2016, N=131.

Mathematics		Entrance exam: Do meet expectations	Meet expectations	Exceed expectations	Sum
Do not meet expectations	NP	12	4	0	16
	NO	2,2	10,9	2,9	16,0
	NPr	75,0%	25,0%	0,0%	100,0%
	SR	6,6	-2,1	-1,7	
Meet expectations	NP	5	62	4	71
	NO	9,8	48,2	13,0	71,0
	NPr	7,0%	87,3%	5,6%	100,0%
	SR	-1,5	2,0	-2,5	
Exceed expectations	NP	1	23	20	44
	NO	6,0	29,9	8,1	44,0
	NPr	2,3%	52,3%	45,5%	100,0%
	SR	-2,1	-1,3	4,2	
Sum	NP	18	89	24	131
	NO	18,0	89,0	24,0	131,0
	NPr	13,7%	67,9%	18,3%	100,0%
		$\chi^2(4)$ = 86,938, p<,001			
		Cramer V = ,576, p<,001			
		rS = 0 ,611, p<,001			

Source: own processing.

N_P – observed frequency, N_O – expected frequency, N_{Pr} – relative observed frequency, χ^2 - chi-square test of independence, SR – standardized residuals, Cramer V – power indicator, rS - Spearman's correlation coefficient, p – value
$1.96 \leq SR < 2.58$ (p <.05); $2.58 \leq SR < 3.29$ (p < .01), SR > 3.29 (p < .001)

We compared the overall performance score of students in Mathematics in 2016/2017 with their overall score of Entrance exam v using Student's t-test for two dependent selections.
Based on its results, we found that there is a statistically significant difference between the overall performance score of Mathematics students in 2016/2017 and their overall score in entrance exam 2017/2018, t (130) = 3,600, p <.001. In particular, it has been shown that students achieved entrance exam (AM = 8.08, SD = 3.239) significantly higher than entrance exam (AM = 7.40, SD = 2.884).

However, it should be noted here that, despite the point difference, students in both subjects achieved on average a performance that met expectations ($5 \leq AM \leq 9$). Thus, the statistically significant difference found is not significant in practical terms. The results are summarized in Table 3.

Table 3. Student's t test on two independent samples – The comparison of the total point evaluation from Entrance exam and Mathematics for year 2016, N=131

	Description			Student's t test on two independent samples		
	AM	SD	SE	t	df	p
Mathematics	8,08	3,239	,283	3,600	130	<,001
Entrance exam	7,40	2,884	,252			

Source: own processing.

AM – arithmetic mean, SD – standard deviation, SE – standard error of estimate, t – Student's t test on two independent samples, df – degrees of freedom, p – significance level

From all this we conclude that after the experiment (which is a part of a project of our faculty) it is evident that the level of students' knowledge form mathematics increased without any further requirement necessitating an additional extent in weekly lesson time. This experiment led the teaching team of our faculty to develop or to modify the existing models focusing on the quantification and monitoring of the effectivity parameters of the pedagogical process.

Table 4. Descriptive statistical indicators of continuous performance for the year 2017

	Entrance exam	Mathematics 2017
Sample size	124	124
Mean	5,15	8,21
Standard error	0,241	0,274
Median	5,00	8,00
Mode	4	8
Standard deviation	2,662	3,081
Variance	7,085	9,493
Skewness	0,130	-0,449
Kurtosis	0,106	0,023
Range	13	14
Minimum	0	0
Maximum	13	14

Source: own processing

6 Conclusions

Each school should have its own quality management system, focusing on all learning processes. It is the employees who should be actively involved in the realization of the changes taking place on the campus. The school should provide regular improvement, in the form of various training and consultations, which should contribute to improving the learning process and improving students' knowledge. Only then can we consider the level of education of teaching staff to be effective if students are regularly trained in their field and bring positive benefits to society.

Improvement in the results of the subject of Mathematics by incorporating new pedagogical processes leads us to further our efforts in the implementation of the same for the subjects of Microeconomics, Operative analysis and Econometrics.

The creation of complex teaching materials accessible via the portal Moodle. The easy accessibility of the portal Moodle (without any necessary expenditure) is the precondition for further development of the experiment's focus and also for the cooperation between the faculties exchanging of monitoring information. The problem of very heterogeneous and ever decreasing knowledge of university applicants, mostly from mathematics, is a problem to face for the majority of Slovak economic faculties in the very near future. The result of our research can be the foundation for the cooperation between the universities but also for the relationship between universities and secondary schools. The results are usable for other subjects in the future, wherever the development of a students' skills is important for economic and trade practice. Because they require the graduates' ability to work actively with the information in any form, it suppresses the extent of memorisation of the information taught. The benefit will also be the appearance of publications which aggregate the individual theoretical and experimental outputs of our research. Last but not least will be the added bonus of the development of the student's self-evaluation system, designed for their internal testing. The student will be able to verify his/her extent of knowledge individually by a simulation of the exam conditions. Quantification of the process' effectivity will enable the teachers to actively use IT support for the creation of all parts of the pedagogical process. It will help them to eliminate ineffective administrative activities and focus their attention on the pedagogical process itself.

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