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Analysis of students' success after working in the ERR teaching framework

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Abstract

Autonomy, solving new problems and managing new situations are competencies that students should acquire during their studies. Active learning is a way of achieving such competencies. It enables students to study the material that is being taught during the classes and to discuss it among themselves. At the same time, the lecturer is the person, who creates the contents of the lesson as well as its realisation, thus guiding the students towards the realisation of the lesson aims. This prevents the possibility of students getting bored and at the same time gives them the opportunity of training for different approaches of problem solving as well as develops their critical thinking. ERR framework enables students' active learning and developing critical thinking in academic year 2015/2016, exercises of financial mathematics were run at two institutions during classes as well as the interaction that today's students require. During the study of higher education in Croatia results were realised by applying techniques from the ERR framework. This paper compares the final exam results in academic years 2014/2015 and 2015/2016 and shows whether there is an influence of the ERR teaching framework on the success of the results at the final exams.

Keywords: Mathematics, ERR framework, active learning, critical thinking.

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1. Introduction

Employers expect from higher educational institutions not only knowledge but also skills like: communication skills, the managing of information, the use of modern information technologies, social skills, especially team work skills and management as well as skills linked to personal responsibility; the clear setting of goals, priorities and time management (Bennett et al., 2000).

At the same time the increased number of high school students that continue their education after high school in western countries is increasing by 50%. Some research shows that approximately 40% of students have problems with adapting themselves to studying at those faculties where teaching is based on the traditional concept of teaching (Benge-Kletzien et al., 2005). This is primarily because of the fact that the way of growing up of today's students has changed in comparison to the previous generations that the college professors used to encounter. According to Tapscott (2010), the web generation has a cooperative approach to work, and in education they force a change of the pedagogical model upon the system, demanding a change from the teacher oriented approach, which is based on teaching, towards a student oriented model, which is based on cooperation. Because of the fact that adults are constantly in interactive communication on the internet, instead of having lectures, students rather want cooperation with the teacher during their period of studying and discovering new things. Therefore, it is necessary to ask students questions and to listen to their answers. It is also necessary to listen to their answers and lead and enable them to find out the answers themselves. Students together with their teachers should participate in creating new learning experiences in which the following elements should exist: choice, adaptation, transparency, integrity, cooperation, fun, speed and innovation (Tapscott, 2010).

The answer to such complex requirements, set by employers on the one side and students on the other side, came with the phenomenon of active learning, which implies a high degree of independence and self-regulation in learning, the possibility of applying various cognitive strategies and specific cognitive skills, that enable noticing key information within given data, analysing and comparing of information, their linking to the already existing pre-knowledge and the critical judgement of the meaning. This way of acquiring information is saved in the long-term memory, which is easily accessible while solving new problems and managing new situations. The very course of learning is based on the communication between students, team work and the cooperation with the teacher (Slavin, 1997).

2. ERR Teaching Framework

One way of creating conditions for active learning is the ERR teaching framework, which has first been described by Vaughn and Estes (1986), and modified by Meredith and Steele (1995). The ERR teaching framework consists of three phases:

1. Evocation – students are introduced into the topic and should think of what they already know about it (i.e. activating pre-knowledge), thus raising interest and curiosity.
2. Realization of meaning – students are introduced to new information they should learn in order to develop their understanding of it.
3. Reflection – students are asked to think about what they have learned in the previous phase (Benge-Kletzien et al., 2005).

Each of the phases has its own particularities, and keeping this in mind, a whole range of techniques can be used in order to achieve each and every specific aim. Therefore, many techniques were used during the realization of the ERR teaching framework in financial mathematics classes. One of the most commonly used techniques was the technique of cooperative learning, called the Jigsaw. The main feature of this technique is that every student gets the opportunity of studying a new part of the material. Then, they prepare, in cooperation with other students, their own short presentation of the material, which is held in front of a small group (Benge-Kletzien et al., 2005). During classes, students

were divided into small groups of five. Each student, within their own group, had to do a set task. After they had all done their individual tasks, they joined the expert group, which consisted of all the students, who were solving the same task. The aim of the expert group was to agree on solutions and to prepare a short presentation of the set task that was presented in the smaller group. Hence, all the tasks of the teaching unit, that were necessary for the understanding and further preparation of the exam, were treated.

3. Research

The research was done at two higher educational institutions in Croatia. At the Polytechnic in Pozega during the summer semester, there was a course on offer called Economic Mathematics II, which was exactly the same in contents as the course Financial Mathematics that was run during the summer semester at the College of Management in Virovitica. Both courses were held twice a week during a period of fifteen weeks. Two school hours were lectures and two hours were practice. During the academic year 2015/2016, practice classes were held at both institutions by applying the ERR teaching framework. The aim was to see, whether the change in working methods had an impact on students' success as well as on the number of taken exams. The academic success of all students in the school year 2015/2016 was compared to the students' academic success from the previous school year 2014/2015.

Since two different groups of students were observed in this study, that is those who attended the course in 2014/2015 and those who attended the course in 2015/2016, the first thing that had to be checked was, whether there was a significant statistical difference in students' pre-knowledge.

In order to prove that there was no such difference, it was necessary to analyse the students' success at the general certificate of education examinations by the ANOVA test.

Table 1. Comparison of students' pre-knowledge at the G.C.E. examinations (end-of-high-school state examinations)

Groups	Count	Sum	Average	Variance		
Column 1	161	7162	44.48447	152.5544		
Column 2	151	7139.5	47.28146	188.9219		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	609.5769	1	609.5769	3.582551	0.059321	3.871631
Within Groups	52747	310	1701516	188.9219		
Total	53356.58	311				

As $p=0,059$, it can be concluded, that there was no statistically significant difference between the arithmetic mean of the studied samples.

In the academic year 2015/2016, after having attended the semester and after having fulfilled all their obligations, 161 students were admitted to the examination. 113 students successfully passed the examination, which is 70.19% of the total number of students, who had the right to take the exam. The grading system in the Republic of Croatia consists of marks ranging from 1 to 5. 1 being the lowest grade representing a fail (insufficient) and 5 being the highest grade (excellent); 2 represents the lowest passing grade (sufficient).

The average success (or mark) of those, who passed the exam, was 2.85, while the average deviation of the average mark was 0.8886. Half of the students or 50% were graded with the mark good or lower and the other half or 50% were graded with the mark good or higher. It is clear that lower grades prevail ($\alpha_3=0.84585$), and the most common mark is sufficient. The distribution of 113

students, who successfully passed the exam, is a little bit more pointed than the normal distribution ($\alpha_4 = 0.02710$).

In the academic year 2014/2015, 151 students were admitted to the examination, after having attended the semester and after having fulfilled all their obligations. 109 students successfully passed the exam, which is 72.19% of the total number of students who had the right to take the exam. 42 students failed the exam or did not even try to take the exam during any of the proposed exam periods. The average success (or mark) of those who passed the exam was 2.83, while the average deviation of the average mark was 0.8662. As in the previous year, 50% of students were graded with the mark good or lower, and 50% were graded with the mark good or higher. Lower grades prevail just as in the previous year ($\alpha_3 = 0.75025$), and the most common mark is sufficient. The distribution of the students, who successfully passed the exam, is a little bit more flat than the normal distribution ($\alpha_4 = -0.20846$).

As $p = 0.90086$, it was proved by the ANOVA test, that there was no statistically significant difference between the arithmetic mean of the studied samples i.e. the working method during classes did not significantly affect the students' success.

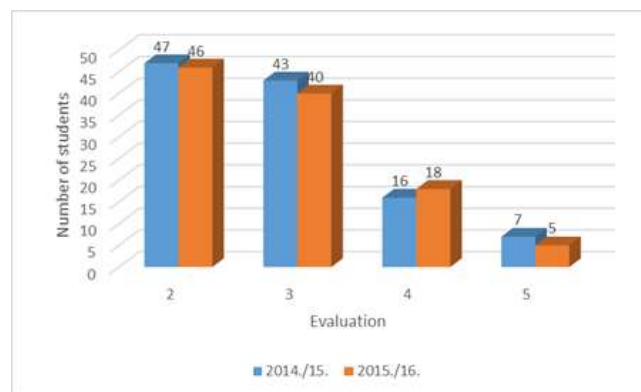


Figure 1. Students' marks in the academic years 2014/15 and 2015/16

Table 2. Comparison of students' pre-knowledge at the G.C.E. examinations (end-of-high-school state examinations)

Groups	Count	Sum	Average	Variance		
Column 1	113	322	2.849557522	0.789664981		
Column 2	109	309	2.834862385	0.750254842		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.01198117	1	0.01198117	0.15553534	0.900864005	3.884074683
Within Groups	169.4700008	220	0.770318186			
Total	169.481982	221				

Considering the number of taken exams in the year 2015/16, there were 11 students more, who passed the exam during the first examination period, whereas there were 6 students, who took the exam at the fifth examination period, and compared to the year 2014/15 there were no such students. The biggest difference is in the second examination period in 2014/15, when 38 students passed the exam compared to just 10 students in 2015/16.

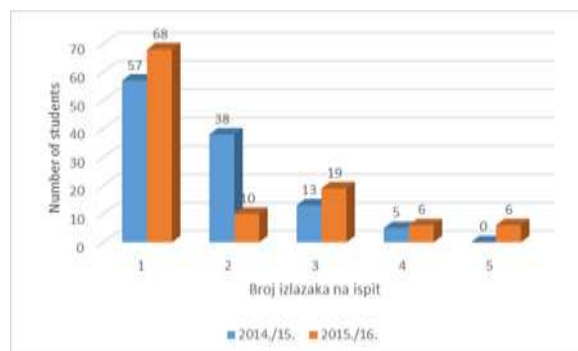


Figure 2. The number of examinations taken in academic years 2014/15 and 2015/16

The ANOVA test proved that, there was no statistically significant difference ($p=0.36914$) in the number of taken exams between those students, who were taught during the semester according to the ERR teaching technique and those who weren't.

Table 3. Comparison of the number of taken exams until the exam was finally passed

Groups	Count	Sum	Average	Variance
Column 1	113	192	1.699115	0.712231353
Column 2	109	199	1.825688	1.497111791

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.888861948	1	0.88862	0.809870208	0.369142624	3.884074683
Within Groups	241.4579849	220	1.097536			
Total	242.3468468	221				

4. Conclusion

Through the evaluation of the students' success and the number of taken exams needed in order to pass the exam, it has been proven, that there is no statistically significant difference between the students, who were taught according to the ERR teaching technique and those who weren't. However, it is necessary to emphasize that in the year 2015/16, 72.19% of the total number of students, who were admitted to the exam, successfully passed, whereas in the year 2014/15 this was 70.19%. Furthermore, it can clearly be stated, that in 2015/16 there were 62.39% of students, who took the exam once and passed it successfully, compared to 2014/15, when only 50.44% of students successfully passed the exam from the first try. The limitation of this study is in the number of observed and compared years, which raises questions that require further research. Seen the fact that the study showed an increased number of students, who passed the exam successfully after they had been taught according to the ERR teaching technique, the question arises whether the use of the ERR teaching framework has an impact on students' self-confidence, which is why more students take their

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exams in the first exam period and successfully succeed, and whether students prefer the more active way of learning by applying ERR framework or whether they prefer the traditional way of teaching.

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