Increasing Students' Motivation and Improving Outcome by Changing the Course Examination from Test to Project on a University Course

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***Abstract* – This paper measures the impact of changing the university course examination from test to project. It was witnessed that the student's motivation was low, as most students took the exam at the last deadline, and their grades were deficient. In order to increase students' motivation, grades, and earlier delivery, the paper authors changed the approach. Instead of forcing students to learn for the exam on particular dates, students were given a set of projects to deliver regularly. This paper is trying to answer the following questions: Does the usage of project-based course results in scoring better grades (Q1)? Does using a project-based course increase the student's motivation to deliver earlier (Q2)? The paper analyzes scores and examination dates for four generations of students – the first two generations were examined through the tests, and the other two were examined through individual projects. The course's learning objectives remained the same, as well as the learning objectives for the courses that precede the course being examined. The paper shows the following results: The average grade for the students rose from 3.31 to 3.74 (Q1), while the average value of exam date changed from 3.01 to 2.20 (Q2).**

Keywords – examination; tests; project-based learning; students' motivation

I. INTRODUCTION

Governed by the well-being of our students, as teachers, paper authors often feel obligated to create content and approach that can light the spark in the students. In order to improve students' achievements at the university, it is often required to use alternative methods and procedures of teaching [1]. The usual organization of the educational process and the philosophy oriented toward convergent thinking that there is "only one right answer" often inhibit creativity rather than develop it [2]. Therefore, it is vital for teaching to be modern and creative in order to increase the motivation for learning and participation of the students in the teaching process [3]. Modern education programs should start with the teachers, to take the role of reflective practitioners and action researchers to create changes to improve the educational system from the inside out [4].

The above presents a challenge and motivation factor to the paper authors and the students. The generations of students today should be governed in learning to solve problems by different research methods in controlled conditions with teacher supervision to become active participants and not passive observers [5]. For example, modern teaching methods like research and interactive teaching, which represent a departure from "ex-cathedra" and aim at the active participation of the students and independent application of the knowledge [6], are proven to create greater interest in students. Also, since the classical approach to studying creates much stress for students, "the teachers should support students' autonomy and facilitate students' academic flow in order to prevent students' burnout" [7].

One of the approaches to be taken is using case studies that are first shaped by teachers' view of the subject and later built upon by expectations, backgrounds, and the student's abilities which help to develop ability in analysis and thinking [8]. As another example, 'design thinking' introduces practical problem-solving that puts the student in the center of the problem, often leading to differentiation and even innovation [9]. Further, applying gamification principles in teaching has shown very good results [10] because "gamification utilizes game mechanics to transform the learning experience into a game, while game-based learning integrates games into the learning process" [11]. Finally, many studies have proven project-based teaching to encourage students' activity and satisfaction that, can increase the student's success [12]. It is even more true for programming courses because students tend to fear the abstract nature of programming. After all, it is tough to realize the purpose of the knowledge gained [13]. It is the situation where project-based teaching and examination shine, which this paper should also prove.

Based on the previously mentioned facts, the current education system requires significant changes to prepare students for future work challenges. Examining the knowledge gained should focus more on the student's creative expression and less on the reproduction of the content [14].

II. EXAMINATION METHODS

As there are many different approaches in programming teaching methods [15], the students should also be provided with a better way of their examination. This study should prove that students examined by tests often need to be more motivated and focused on the minimum of the content that ensures them a passing grade. That presents a considerable problem because classes and exams should reflect their future jobs; therefore, being unmotivated for the content

means being unmotivated about the work they will soon perform as programmers.

Traditionally, the course Accessing data from program code tested students on midterms, where students were obligated to answer the tests related to the classes' content. The problem with this approach is that students learn for the test only and, therefore, easily find patterns examined on the written tests and concentrate on the minimum to pass. This fact has been proven throughout the years because it was witnessed that most students took the test at the last deadline and scored poorly, just about enough to pass.

In order to increase students' motivation and improve the outcome, it is decided to change the course examination to project-based. For that matter, students should focus more on the content and on applying their understanding of the concept practically. The skills generated in this process become part of their programming knowledge and, therefore, must be remembered. Paper authors are aware of that fact from their approach to programming – every concept applied to a solution of a problem becomes part of our toolbox used to fix future problems. In that sense, the grade achieved by the student reflects their learned skill because this skill becomes practical and applicable. Project-based learning is already recognized in Croatia's current curricular reform [16].

Moreover, this paper tries to prove that when students engage individually, their interest rises. They are more motivated to deliver quality projects they can eventually put in their portfolios to show their future employers. In that sense, it simulates the natural world, which is not artificial but realistic.

While tests create much stress manifested in a particular moment [17], the project gives a lot more time to investigate the problem and research other solutions to the problem to apply them as their own. The project has to be well thought out, planned, and programmed in a lot more time, giving students a chance to refactor and change wrong ideas into new cognition.

Finally, throughout the years of teaching, authors concluded that programming is not a field to be studied in a conventional sense but to be constructed and built upon solving problems. The more students do programming, the better they understand the concepts and the reasoning behind them. It is impossible to understand the need for an approach or a concept if the student does not face a problem that is hardly solved without it. Because of that, it is of great importance to face as many problems as possible in lifelike projects to become more versatile and ready for the problems in real projects they should be prepared for [18]. On the other hand, tests make them memorize concepts without deepening the true nature of the problems the concepts should solve.

III. RESEARCH

This research aimed to evaluate the impact of changing the course examination from test to project on the university course Accessing Data from Program Code (ADfPC). For years, it was witnessed that the student's motivation for the course mentioned above is relatively low, which was proven by the fact that most students took the exam at the last deadline, and their grades were deficient. In order to increase students' motivation and grades, the paper authors decided to change the approach. Instead of forcing students to learn for the exam on particular dates, students were given a set of projects to deliver periodically, which should have encouraged them on a more individual approach and greater interest. In essence, this paper aims to answer the following questions.

- Does the usage of project-based course results in scoring better grades? (Q1)
- Does using a project-based course increase the student's motivation to deliver earlier? (Q2)

The study involved 419 students from 6 generations who attended the ADfPC course and took a course exam in the spring semesters starting from the academic year 2016/2017 to 2021/2022. Table I shows the number of students included in the research according to the academic year in which they studied and took the course. One hundred seventy-three students took the classic exam, and 246 took the project assignment. For this research, we will name the 173 students who took the classic exam as G1 and 246 students given by project assignment as G2. G1 and G2 were taught by the same lecturer, according to the same materials and methodology. The only difference was that G1 students took the classic exam, while G2 students were given the exam as a project assignment.

Table I. Distribution of students in the academic year

	16/17	17/18	18/19	19/20	20/21	21/22
Students	51	56	66	58	98	90
Is project-based	NO	NO	NO	YES	YES	YES

At the beginning of the study, the aim was to check whether there was a statistically significant difference in the prior knowledge of Object Oriented Programming (OOP) and Introduction to Databases (ItD) for both groups, students given the definitive test and students given by project assignment. It has to be determined whether to exclude the difference in prior knowledge for experimental and control groups as an essential factor in the exam results. Based on previous teaching experience, the knowledge from the second-year courses OOP and ItD is a crucial prerequisite for successful learning and adoption of course content ADfPC, which students enroll in the third year of study. For this purpose, data on students' grades from the control and experimental groups were processed. All students involved in the experiment passed the OOP and ItD courses. Grades at higher education institutions in Croatia are as follows:

- Grade 2 - Sufficient
- Grade 3 - Good
- Grade 4 - Very good
- Grade 5 - Excellent

Table II shows the distribution of students' grades in the OOP course.

Table II. Distribution of students' grades on the OOP course

	Grade 2	Grade 3	Grade 4	Grade 5	Total
G1	27 (15.6%)	59 (34.1%)	47 (27.2%)	40 (23.1%)	173
G2	42 (17.1%)	80 (32.5%)	76 (30.9%)	48 (19.5%)	246
Total	69 (16.5%)	139 (33.1%)	123 (29.4%)	88 (21.0%)	419

Thus, the total sample consists of N = 419 students, of which 173 students from G1 are in the control group and 246 from G2 are in the experimental group. The $\chi 2$ test was used for statistical data processing. A null hypothesis was set:

H_0 = the G1 and G2 groups do not differ statistically significantly according to the obtained grades from the OOP course distribution.

Assuming no significant difference exists between the control and experimental groups, the proportion of specific scores observed should be the same in both groups. Based on that, a table of expected frequencies was obtained. According to χ^2 test specification, the number of degrees of freedom (labeled v) is 3.

The limit value of χ^2 with 3 degrees of freedom at the significance level $p<0.05$ is 7.815. Since the calculated value of χ^2 in the experiment is smaller (1.3745), the H_0 was accepted, i.e., there is no statistically significant difference in the distribution of the obtained grades on the OOP course between G1 and G2 groups.

The same method also processed data on grades from the ItD course. Tables III shows students' grades' distribution on the ItD course.

Table III. Distribution of students' grades on the ItD course

	Grade 2	Grade 3	Grade 4	Grade 5	Total
G1	37 (21.4%)	49 (28.3%)	47 (27.2%)	40 (23.1%)	173
G2	50 (20.3%)	65 (26.4%)	66 (26.8%)	65 (26.4%)	246
Total	87 (20.8%)	114 (27.2%)	113 (27.0%)	105 (25.1%)	419

The limit value of χ^2 with 3 degrees of freedom at the significance level of $p<0.05$ is 7.815. Since the calculated value of χ^2 in the experiment is smaller (0.8413), the H_0 was accepted, i.e., there is no statistically significant difference in the distribution of the obtained grades on the ItD course between G1 and G2 groups.

In this research, we were interested in whether the change in how knowledge is tested will lead to statistically significant differences in students' final results and whether this change will motivate students to take the exam earlier.

Q1: By analyzing the grades of students from group G1, as well as from group G2, we concluded that the average grade of students from group G1 is 3.31, while the average grade of students from group G2 is 3.74, which made a significant difference in favor of the G2 group.

Table IV. t-test results

	G1	G2
Mean	3,312139	3,735772
Variance	0,97177	1,223776
Observations	173	246
Pooled Variance	1,119831	
Hypothesized Mean Difference	0	
df	417	
t Stat	-4,03457	
p(T<=t) two-tail	6,51E-05	
t Critical two-tail	1,965669	
H_0: The difference between G1 and G2 group is not statistically significant		
t = -4.03457, t critical two-tail = 1.9657, df = 417, $p = 6.5x10^{-5}$, $p < 0.05$		
We do not accept H_0 hypothesis		

Two-tailed t-test has been made to check if there is a statistically significant difference between those values. The results are shown in Table IV. H_0 hypothesis cannot be accepted based on the calculated p-value, so an alternative hypothesis has been accepted to show that the difference between values is statistically significant.

Q2: At Algebra University College, for each course, students have 5-time slots spread over approximately 12 months during which they can take the exam. We can mark these terms for research with 1, 2, 3, 4, and 5. We are interested in the average value of the term in which students from group G1 passed the course AdfPC, as well as students from group G2, and we are interested in whether the differences between these significantly different values.

The research was conducted after all 419 students had passed the exam on one of the five possible dates. Two-tailed t-test has been made to check if there is a statistically significant difference between those values. The results are shown in Table V. H_0 hypothesis cannot be accepted based on the calculated p-value, so an alternative hypothesis has been accepted to show that the difference between values is statistically significant.

Table V. t-test results

	G1	G2
Mean	3,00578	2,203252
Variance	1,982525	1,550357
Observations	173	246
Pooled Variance	1,728613	

Hypothesized Mean Difference	0	
df	417	
t Stat	6,151699	
p(T<=t) two-tail	1,8E-09	
t Critical two-tail	1,965669	
H_0: The difference between G1 and G2 group is not statistically significant		
t = 6.1517, t critical two-tail = 1.9657, df = 417, p = $1.8x10^{-9}$, p < 0.05		
We do not accept H_0 hypothesis		

Analyzing the dates for which the students took the exam, we concluded that the mean value of the exam date of students of group G1 was 3.01, while the mean value of the exam date of students of group G2 was 2.20. That is a visible change in the sense that students who worked on the project assignment, on average, took the exam earlier.

Based on many years of experience teaching ADfPC, the authors used grades from OOP and ItD courses to measure the student's prior knowledge as the prerequisite courses for the ADfPC. It would be interesting to show by statistical processing the correlation between the output results of these courses and the output result of the ADfPC course, which can be an exciting area to explore in the future. The plan for the future is to expand the scope of research to other courses.

IV. CONCLUSION

For years, it has been noticed that students' motivation is low when they collect points by taking classic exams. The idea behind this paper was to positively affect the observation by introducing project assignments instead of well-known exams.

The study targeted the course Accessing Data from Program Code (ADfPC), on which project assignments have been used for three consecutive years. The study involved 419 students from 6 generations. The first three generations (G1 group) have 173 students that took the classic exam, and the remaining generations (G2 group) have 246 students that took the project assignment. It was shown that there is no statistically significant difference between the groups concerning their level of prior knowledge. The authors of this research were interested in two questions:

- Does the usage of project-based course results in scoring better grades? (Q1)
- Does using a project-based course increase the student's motivation to deliver earlier? (Q2)

By processing the results of the groups, the obtained results showed the following:

- The average grade of students from group G1 is 3.31, while the average grade of students from group G2 is 3.74, which made a significant difference in favor of group G2.
- Students from group G1 passed the course in an average of 3.01 exam periods, while group G2 in 2.20 exam periods, which is a visible change in the sense that students who worked on the project assignment, on average, took the exam earlier.

The research showed a significant correlation between introducing project assignments in the ADfPC course, scoring better grades, and increasing students' motivation to deliver projects earlier.

The study's results could encourage other researchers to investigate further the impact of introducing project assignments to different university courses, primarily to motivate students to practice more.

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