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The Effects of Flipped Learning Method on Students' Perception and Learning of Java Programming*

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The aim of this study is to evaluate the effects of flipped learning method on students' perception and learning of Java programming where the content of the course is delivered in two ways with two groups of students, one experimental group and one control group. The experimental group was taught with flipped learning method where all materials were developed by the researcher in a form of pre-recorded video lectures delivered to the students and in-class group activities supervised by the instructor. The control group had traditional weekly lectures and exercises at home. This study was conducted for 10 weeks with 174 students in total and employed an explanatory mixed method research design with qualitative and quantitative approaches. The data collected through the achievement test, Course Evaluation (CEQ), and Students' Perceptions/Opinions of Flipped Learning in Engineering Education Questionnaire (SOFLEEQ) were analyzed by using descriptive and inferential statistical analysis techniques. For data analysis, SPSS 24.0 was used and alpha level was determined as .05. Significant differences were found between the experimental and control group in terms of students' achievements and positive reactions towards flipped learning methodology. In the experimental group, students' learning attitudes, motivation and self-evaluation were enhanced. The findings show that flipped classroom outperforms traditional classroom and students' perception toward flipped learning became more positive.

Keywords: engineering education; flipped classroom; flipped learning; inverted classroom; students' perception

1. Introduction

In recent years, there are important developments in the fields of economy, technology, education, and innovation [1]. Among these developments, education and technology emerge as the most important areas [2]. Flipped learning as an instructional procedure creates a dynamic and intelligent learning environment where students work under instructor supervision during in-class learning and study the teaching material at home [3]. Lage, Platt, and Treglia [4] indicated that there is a gap between instructors' teaching style and students' learning style that's why alternative forms of teaching should be considered to embrace all types of learners. Bergmann and Sams [5], habitually cited as the pioneers of the application of the idea of flipped learning, recorded all their classes, lectures, exercises so the students would not miss any teaching material and it turned out to be a real success.

Instructors are including flipped learning method in their teaching in a way that the teacher ''distributes'' lectures before class in the form of pre-recorded videos, and during the class time engages on learning activities with students that include cooperation, interaction, and supervision [6]. The greatest advantage of providing the lecture in this format is that students can review the videos as many times as they want. Having watched the videos at home, students become ready to do some activities related to the videos in the classroom [7] that's why in a flipped classroom environment students participate in class exercises more actively rather than in the traditional classroom [8].

Even though the interest in flipped learning is increasing, still, there isn't an agreement on what flipped learning is and how effective it is in improving students' performance in engineering education. Therefore, when flipped learning is applied in engineering education, it is wondered what the results will be, and it is seen as a necessity to be taken as a research problem and to present its results. This work tries to conclude that flipping a classroom affects students 'achievement and perception decidedly. Moreover, it is of an extraordinary significance as far as being one of the few investigations identified for flipped learning usage at a university level to expand the adequacy of flipped learning in engineering courses.

1.1 Theoretical Framework

In a flipped learning approach, classroom time is

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not used for delivering the materials, but for active learning and supervised exercises [9]. It is important to examine the theories and models in which flipped learning is based on, and compare with previous studies results to design the most suitable in-class activities and out of class materials.

Flipped learning method uses a combination of theories to provide the best learning environment for students. This study primarily uses a synthesis of the cognitive constructivism of Piaget [10], the zone of proximal development [11] and mastery learning [12]. Based on the Piagetian cognitive constructivist theory, to achieve higher learning rate students need to engage with their peers having 'cognitive confrontations' which will lead to higher retaining of knowledge. Students should cooperate with one another, exchange ideas and learn the concepts in their own manner [13]. That's why, in this study are created interactive learning assignments and exercises in line with previous studies [4, 14, 15] and supervised by the professor as suggested by Uredi [16]. According to Vygotsky, the learning process happens inside the zone of proximal development which according to Ireri & Omwenga [17] is ''the distance between a student's ability to perform a task under adult guidance and additionally with peer collaboration and the student's ability of solving the problem independent''.

Eppard & Rochdi indicated that ''Using mastery learning, students learn in their own pace'' [18, p.37] which is exactly what flipped learning offers to students, mastering objectives in their own way, according to their own needs. Bergman and Sams [6], indicated that flipped learning is based on mastery learning because it offers instructions that are differentiated, and provide a framework for constructive feedback.

In this study, students use video lectures to study the material at their own pace, watch it as many times as they need, take notes, do quizzes, prepare for next classroom activities, etc. Preparing for the next classes is a very important stimulus that improves the overall performance of the students [19].

1.2 Purpose of the Study

This study aims to compare the educational effectiveness of flipped classroom instruction consisting of in-class activities and video lectures to traditional classroom instruction in a university-level introduction to programming with Java course for engineers.

To achieve this goal, the following questions were sought:

1. Is there a significant difference between the academic achievements of the students in the experimental and control group?
2. Is there a significant difference in the perception of software engineering students about flipped learning in the experimental group in terms of: Course Evaluation (CEQ), and Students' Perceptions/Opinions of Flipped Learning in Engineering Education Questionnaire (SOFLEEQ))?

The achievement test was applied to both groups as pretest in the beginning of the course and posttest at the end to show the impact of flipped learning methodology in engineering courses. Likewise, the above mentioned questionnaires are used as data collection tools to collect the quantitative data within the instruction of Introduction to Java Programming with flipped learning approach.

2. Literature Review

In the literature, there are numerous of studies related to flipped learning usage at a university level that are conducted in different fields, from educational studies to medical science but only a few of them with engineering students in programming courses [19, 20]. These studies had positive results in favor of flipped learning approach in contrary to traditional learning approach and served as a motivation for this study.

Most of the studies investigated the effects of flipped learning method on students' achievement, academic performance and other affective variables like motivation, teamwork, etc. Hughes [21], noted that a classroom can be flipped in many ways. However, for a flipped classroom experience to be effective it ought to incorporate: very well prepared pre-class materials, tools to ensure that students will finish the out-of-school work, attractive in-class activities [85] and opened lines of correspondence with the professor [22]. From this perspective, a comprehensive and coherent pedagogy should be implemented to fulfill the limitations of the curricula [23] and move from professor centered to student-centered learning approach [24]. Motivation is also an important factor for university students' preferences for new learning approaches [25].

Flipped learning has many advantages like enhancing retention, makes learning easier, promotes regular study habits and hands-on activities during class time, improves comprehension skills and develops computer skills [26]. Moreover, it positively affects academic achievement, collaboration skills and satisfaction levels of students [27]. Students learn more when they have opportunities to apply what they learn [28] and likewise benefit when they are occupied with the teaching of their peers [29]. In general, the students seemed to value

the flipped classroom design, even though they identify some difficulties [30] but still were ready to take part in a flipped classroom [31]. The flipped learning method is especially valuable in engineering where critical thinking abilities are significant and fundamental for a successful career in engineering [32]. Flipped classroom goodly affects students' performance and is an effective learning method for the engineering courses [33–36] and for programming courses as well [20].

Regarding student perception of flipped learning method, students have practically positive reaction in general [37, 38]. Still, there are some studies which highlight the negative aspects of flipped learning method like students coming unprepared to classes [39], more burden and pressure [40], needing extra support and assistance in the beginning of the course [52] and not being satisfied with flipped methodology [41, 42].

3. Methodology

In this section, the model of the study, participants, data collection technique and data analysis are given.

3.1 Research Method

In this research, to evaluate and compare the views of students who receive an introduction to programming with Java course based on flipped learning, the mixed method was used with qualitative and quantitative approaches. This method involves collecting, analyzing and combining qualitative and quantitative data [43]. In this study, the explanatory pattern design described by Creswell and Clark [44] was used. In the explanatory pattern, quantitative and qualitative data take place in two stages and sequentially.

3.2 Participants

The participants in the research study are software engineering students in the course: Introduction to Programming with Java who are divided randomly into two equal groups of 87 students. They are first year students that haven't got any programming courses before. About 94% are younger than 25 and 3% between 25 and 30 years old. More than 77% of them have never used or heard about flipped learning. The research took place at a university in the fall semester of the 2018/19 school year.

3.3 Video Materials

Following recommended best – practice, the video lectures were 15 min long and were recorded with Screencast-o-matic. Students prefer shorter, rather than longer videos [45]. Kaw and Garapatti [46] recorded two hundred 10 min of video lectures on numerical methods. For validating the work of video materials there were taken five experts opinion, three experts of the field, with whom is discussed the content of the videos and two educational technologist experts with whom the format and delivery of the videos are consolidated.

3.4 Quantitative Section of Research

In this study conducted by the researcher, to collect quantitative data are evaluated students' achievement in both, the experimental group and control group where pre-tests and post-tests are performed and students' opinion in experimental group, same as pre-test and post-test.

In the experimental model, the researcher provides the research area by producing the data that he wants to observe among the variables he controls to explore cause-effect relationships. Pre-test and post-test are part of experimental designs used in social sciences. First, subjects are randomly assigned to groups from the university that is considered suitable for the experiment. Then, the subjects in the experimental groups have measurements of the dependent variable before they begin to apply. In the application process, the experimental process whose effect is tested is applied to the experimental groups. Finally, the measurements of the dependent variable of the subjects in the groups are obtained using the same tool or co-form [47, 48].

The experimental research model was created as stated in Table 1.

Between the experimental and control groups, introduction to programming with Java achievement test (AT) [$t(172) = 0.455$ $p > 0.05$] there was no statistically significant difference between the pretest results. Hence, one can be said that both groups are equivalent and the results are shown in Table 2.

3.5 Data Analysis

To collect the quantitative data within the instruction of introduction to Programming with Java course with flipped learning and get the students' views, three data collection tools mentioned in Table 1 were used in this research.

Table 1. Experimental Research Model

Group	Pretest	Experimental Design	Post-test
Experimental Group	T1, T2, T3	Flipped Learning	T1, T2, T3
Control Group	T1	Traditional Instruction	T1

T1: Introduction to programming with Java achievement test.
T2: Course Evaluation Questionnaire.
T3: Student Perceptions/Opinions of Flipped Learning in Engineering Education Questionnaire.

Table 2. Independent samples t-Test Results for Pre-Test Introduction to programming with Java achievement test scores of the experimental and control groups

Group	*N*	Mean	SD	df	t	p
Experimental Group	87	9.46	9.393	172	0.455	0.650
Control Group	87	8.85	8.236			

3.5.1 Introduction to Programming with Java Achievement Test

To measure the levels of the students before the experimental procedure, 25 open-ended questions were developed according to the content of the university curriculum. Developed questions in the introduction to Programming with Java achievement test have been prepared by taking into account the skills of writing and understanding the program, and a different skill has been sought for each question. The validity of the questions was tested by applying to three expert opinions, all from the area of programming. The reason for using open-ended questions in the test supported by the results of the research conducted by Moreno-Marcos et al. [49] is because open-ended questions are more effective types of questions in measuring students' programming skills.

3.5.2 Course Evaluation Questionnaire (CEQ)

As another data collection tool, the "CEQ" was used. The theoretical and empirical basis of the CEQ is the development work of Ramsden and Entwistle [50] and subsequent studies with British and Australian students which have demonstrated aggregate-level associations between the quality of student learning and students' perceptions of the learning environment [51–55]. These studies indicate that the CEQ offers a reliable, verifiable and useful means of determining the perceived teaching quality of academic units in institutions of higher education. The questionnaire consists of 25 items scored on a five-point Likert-type rating scale from "strongly agree" to "strongly disagree". Twenty-four of the items combine to form five scales (good teaching, clear goals and standards, appropriate assessment, appropriate workload, and generic skills) plus there is an overall satisfaction item. Raw scores are recoded as follows: a raw score of 1 ('strongly disagree') is recoded to –100, 2 to –50, 3 to zero, 4 to 1 50, and 5 ('strongly agree') to 1 100, eliminating the need for decimal points. The scoring of negatively worded items is reversed. In interpreting CEQ results, a negative value corresponds to disagreement with the questionnaire item and a positive value to an agreement with the item. Positive high scores indicate high course quality as perceived by graduates. Cronbach's alpha on the remaining 196 responses for the questionnaire was 0.833, which suggested that the survey tool had a good level of internal consistency and reliability [53].

3.5.3 Student Perceptions/Opinions of Flipped Learning in Engineering Education Questionnaire (SOFLEEQ)

To have student perceptions of flipped learning in engineering education a questionnaire form containing 23 items was developed by the researchers inspired from previous researches [56–61]. The researcher was asked to answer the questions by distributing the questionnaire form to the students. The average time for students to complete the questionnaire was 20 min.

The Cronbach Alpha internal consistency coefficient of the questionnaire was 0.83.

3.6 Qualitative Section of Research

The aim of this qualitative research is to describe the experiences of a group of students who participated in a flipped classroom at the subject introduction to Programming with Java and to reveal the perception and views about flipped learning video materials, in-class activities, homework, quizzes, teamwork, and interaction with the professor, peer communication, etc.

3.6.1 Research Group

As a research group for qualitative research is taken only the experimental group with a flipped learning approach. Moreover, there were chosen 21 students according to their results in the subject Introduction to Programming with Java Achievement Test (AT). Students chosen for the qualitative section of the study were selected according to the maximum variation sampling method. The sample was selected to represent the heterogeneity of perspectives and perceptions [62, 63].

3.6.2 Data Collection Tool

Data were collected through student interviews given at the end of the semester. The interview content was created based on the existing instruments or was newly developed by the researcher [64–66] to answer the research questions.

3.7 Analysis of the Data

SPSS version 24 was used to evaluate the data

obtained from the study and to create tables. Percentage (%), mean *M*, frequency (f) and standard deviation (Sd) were used for the analysis of the data collected to answer the sub-objectives. In the Kolmogorov-Smirnov test conducted prior to the comparison of the experimental groups and the control group according to the scores before and after the training, it was accepted that the data showed a normal distribution as $p > 0.05$ was obtained. Because the data show normal distribution then independent samples t-test, paired t-test and multivariate analysis of variance (MANOVA) tests were used in this research.

In all statistical analyses, $p = 0.05$ was accepted as the level of significance. The mean and standard deviation values of the items for the evaluation of the responses of the students to the scale and questionnaires were determined with the help of tables. The qualitative part of the research is analyzed through content analysis. Answers of the student interview transcripts were reread, but more systematically to create categories of key concepts, phrases, and patterns [65, 67, 68].

3.8 Limitations of the Study

The findings of this study have to be seen in light of the following limitations:

1. This research study was limited to the data obtained from the students that were enrolled on the course: Introduction to Programming with Java during the fall semester of 2018–2019 at a university located in Kosovo, 174 students in total.
2. The study was limited to 28 hours in-class implementation of flipped learning methodology and 28 lab classes in Introduction to programming with Java course.
3. The study experiment was conducted only by one teacher (the researcher), therefore, to generalize the results for further studies it can involve a variety of different leveled course from different teachers.
4. The members of both experimental and control group were randomly selected by the University, but the good thing is that the independent samples t-Test results showed there were no significant differences between the experimental and control group.
5. All interviews were conducted by the researcher. The answers might have been influenced by the fact that students might want to satisfy the professor, although steps were taken to ensure students that their answers won't affect their evaluation.

4. Results

The findings obtained in line with the objectives and sub-objectives set out in this chapter are included.

4.1 Results of the Quantitative Data

4.1.1 Evaluation of the Post-Test Introduction to Programming with Java Achievement Test Scores of the Experimental Group and Control Group

In the study, it was investigated whether there was a significant difference between the experimental and control groups according to pre-test and post-test scores.

Because the data show normal distribution then two-factor repeated measures ANOVA test was used to determine whether there was a significant difference between post-test "Introduction to Programming with Java achievement test" scores of the experimental and control group students. There is a significant difference between the experiment and control group [$f(1.172) = 6.385$, $p < 0.01$, $\eta^2 = 0.036$]. Thus, we can say that the "Introduction to programming with Java achievement test" scores of the experimental group students were higher than the control group ($M = 26.25$) according to the post-test ($M = 31.69$). All results are presented in Table 3.

As seen in Fig. 1, there is a significant difference between the introduction to Programming with Java achievement test average scores of the experimental and control groups. Thus, we can say that the post-test achievement scores of the experimental group students were significantly higher than the pre-test success scores.

4.1.2 Examining the Students' Opinions/ Perceptions of Flipped Learning in Engineering Education

To determine the students' opinions about the course before the experimental process, the student perceptions of flipped learning in engineering education questionnaires were applied to the experimental group. This questionnaire was then re-applied as post-test after the experimental procedure. The paired samples *t*-test was used to examine

Table 3. Experiment and control group Introduction to programming with Java achievement test results

	Group	***M***	**Sd**	**N**
Pre-test	Experimental	9.46	9.393	87
	Control	8.85	8.236	87
	Total	9.16	8.813	174
Post-test	Experimental	31.69	11.351	87
	Control	26.25	9.017	87
	Total	28.97	10.578	174

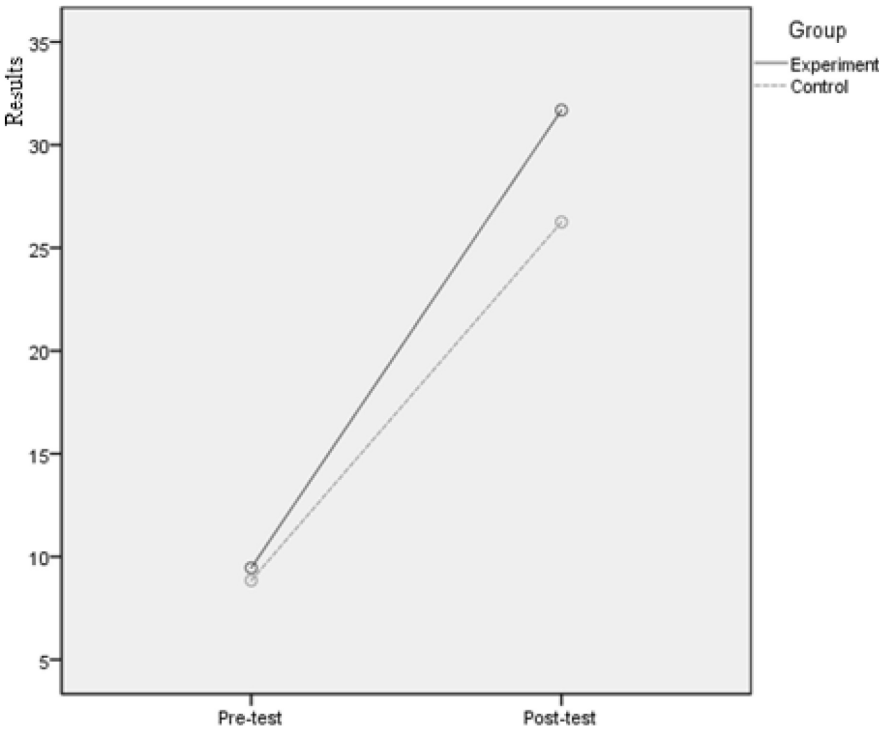

Fig. 1. Comparison of pre-test and post-test scores for the introduction to Programming with Java achievement test of experimental and control group students.

the pre-test and post-test course evaluation scores of the experimental group.

When the calculations are examined, it is observed that there is a significant difference in all items according to the paired samples *t*-test ($p < 0.05$). Therefore, the student perceptions of flipped learning in engineering education scores of the students for the course introduction to Programming with Java were further increased after the experimental process and the views of the students become more positive.

According to the results, student views became more positive on the items that this course was not significantly harder than their other software engineering courses. Furthermore, they felt that the usage of videos and online material in advance of class helped to prepare them for lectures better than traditional textbook readings.

If given the opportunity, ''they would enroll in another class taught using the flipped classroom'' approach is one of the positively increased views for the students.

By paired sample *t*-test results students became more positive also on that they liked the idea that they can re-listen the videos and online materials before exam as much as they want, they liked it when the professor supervised them during problem-solving activities, it was easier for them to do exercises in class rather than at home, they did not need to be well prepared for the flipped approach, they liked interacting with the lecturer and peers in the workshops etc.

4.1.3 Examining the Pre-Test and Post-Test Course Evaluation Scores of the Experimental Group

To examine the students' course evaluation in general, at the end of the experimental process a questionnaire form was implemented to the students.

When the results are examined, it is observed that there is a significant difference in all items according to the paired samples *t*-test ($p < 0.05$). Therefore, the students' perceptions about the course evaluation scores for the course introduction to Programming with Java were further increased after the experimental process and the views of the students become more positive.

According to the results, student views become more positive on the items that show that it's easier if you know the standard of work expected. Furthermore, their views became more positive on their problem-solving skills increased by this course.

4.2 Results of the Qualitative Data

On qualitative analysis of answers from our interviewees, three themes emerged. In Table 4 we described the three themes in three categories that are identified, along with codes that are grouped according to the themes, and comments from inter-

Table 4. Categories emerged from the results of qualitative data

Category	Subcategory	Comment
Learning process out of the classroom	Increased students autonomy Learning at their own pace Re-listening to lectures every time they need Pausing and taking notes Less distraction	. . . *felt freer in my studying process.* . . . *in control of my own learning* . . . *made me take more responsibility for my studies* . . . *we have our lectures in our pockets*
Engagement in flipped classroom	Group work Closeness with the professor The advantage of being pre-prepared for the next lecture Monitored process of solving problems Enriched relationships Increased enjoyment of the learning experience	. . . *enjoyed working in groups* . . . *motivates me to work harder* . . . *always wanted to solve the programming exercises on the whiteboard* . . . *this methodology made us felt more close with the professor* . . . *in class activates became really fun*
Negative aspects of the flipped learning approach	Skepticism The stressful process of learning Increased effort Difficulty in adaptation	. . . *confused and skeptic about this new methodology* . . . *this methodology doubles the work* . . . *that it was really stressful the process* . . . *needs a lot of effort and time* . . . *think this new way of studying should have been introduced later on our studies*
Learning process out of the classroom	Increased students autonomy Learning at their own pace Re-listening to lectures every time they need Pausing and taking notes Less distraction	. . . *felt freer in my studying process* . . . *in control of my own learning* . . . *made me take more responsibility for my studies* . . . *we have out lectures in our pockets*
Engagement in flipped clasroom	Group work Closeness with the professor The advantage of being pre-prepared for the next lecture Monitored process of solving problems Enriched relationships Increased enjoyment of the learning experience	. . . *enjoyed working in groups* . . . *motivates me to work harder* . . . *always wanted to solve the programming exercises on the whiteboard* . . . *this methodology made us felt more close with the professor* . . . *in class activates became really fun*

viewees that best illustrate these issues. These categories are the learning process out of the classroom, engagement in the flipped classroom and negative aspects of the flipped learning approach.

5. Discussion

In this section are discussed the implications of the results to the research questions in details.

According to the achievement test results of this study, there was a significant difference between the experimental and the control group in the post-test achievement results. The reason for these results might be the fact that students felt excited about this new methodology, they were motivated to try a new form of teaching and learn with video materials at home. Also, the time spent in class for exercises and problem-solving activities, group work, was all an additional asset for students to get better marks. Students in a flipped classroom got higher scores on achievement tests on previous studies as well [5, 69–73]. Still, there are studies that show no difference in achievement results between two groups like in the study of Shiau et al. [41] which indicates that there was no significant difference in students' performance comparing the traditional setting to the flipped classroom setting. Or some studies go even further showing negative effects in students learning achievement in technical colleges [74, 75].

It is observed that there is a significant difference in all items according to the paired samples t-test. Therefore, the student perceptions of flipped learning in engineering education scores of the students for the course Introduction to Programming with Java were further increased after the experimental process and the views of the students become more positive. The study results are in accordance with most of the studies on perceptions of students about flipped learning which are pretty much positive results toward this new methodology affecting students' performance, motivation, teamwork, etc.
According to students, flipped learning gives them a better study atmosphere, more opportunity to interact with other students, more control over what they learn, how they learn and investigating content at their own pace. [37, 38, 76–82]. Still, we cannot

generalize things because for example, in a research made by Tang et al. [40] even though students in flipped group performed better than students in traditional groups still there were some drawbacks that should be reconsidered because students reported more burden and pressure during their flipped classroom. This implies that students need additional time and support at the beginning of the application of flipped learning method so they can understand it better and face the challenges of this approach easier [41].

Students prefer learning through video materials, same as in the research study of Aydin, [83] where students stated that they could learn the content according to their own learning speed thanks to video materials. Umutlu & Akpinar [7] prepared different video materials which by following students learning style were the most important asset when examining the impact of flipped learning on students' achievement. In the current study, students indicated that learning from video materials is fun rather than learning from various books, same as in the research study of Boyraz [84].

Flipped learning method has positive reviews from the students for delivering the teaching material and positive evaluation of the course itself because it invokes active learning among the students, resulting in better performance [58]. In comparison with the traditional methodology has shown itself to be a more effective tool regarding academic performance evaluated in a quantitative and qualitative way at the university level [27], and turned out to be an efficient learning methodology for the engineering courses [35].

6. Conclusion

In this research, it was determined that there was a significant difference between the introduction to Programming with Java achievement scores of the experimental group students taking the lesson in the flipped learning environment before and after the education. Furthermore, after the research, it was found that there was a significant difference between the achievement scores of the students in the experimental group and the achievement scores of the control group. The significance difference was in favor of the experimental group.

Likewise, according to qualitative data collected it can be concluded that students are mostly satisfied with the flipped learning method, giving them autonomy in their learning, better cooperation with the professor and classmates while only being a little skeptic at the beginning of the course and afraid of adaption towards this new methodology.

The flipped classroom did create a higher level of satisfaction for the students and did appear to engage the students more actively as measured by statistically significant higher student evaluation results in the flipped classroom as compared to the control group in traditional format. So, according to the findings of the study, students in the experimental group outperform students in the control group in all the measuring instruments. Still, studies need to continue to provide details regarding the integration of out-of-class and in-class activities so that there is more information regarding good practices and guidelines for flipped classes in engineering education.

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