Investigation of Academic Achievement and Self-Regulation of Students in Flipped Classroom

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Abstract This study aims to seek the effect of flipped classroom method on students' academic achievement in computer programming lessons and to find out the correlation between flipped classroom method and variables affecting self-regulatory learning skills (i.e., self-efficacy, anxiety, satisfaction, interactive learning environments, usability, and self-regulation). A pre-test and post-test control group quasi-experimental design was used in this study. Participants are 252 vocational college students registered to the electronics and communication technology department at a state university in Balıkesir, Türkiye. Computer programming achievement test and self-regulation scale which was developed by [1] and adapted to Turkish by the researcher were used as data collection tools. The findings of the study revealed that flipped classroom group has outperformed the traditional classroom in terms of academic achievement. Additionally, significant and positive correlations were found between academic achievement and variables affecting self-regulation for flipped classroom method while there is a significant and negative correlation between academic achievement and anxiety.

Keywords: flipped classroom method, programming education, academic achievement, self-regulation

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1. Introduction

The flipped classroom is a recently popularized teaching and learning approach upon which novel research has progressively been conducted [2]. In the traditional classroom method, the lecture is performed by the teacher within the boundaries of the classroom and the homework and projects are completed outside the classroom mostly at home. In the flipped classroom method, on the other hand, this process is reversed in a way that the pre-recorded video lectures are studied by the students prior to the classroom lessons, and the activities such as teamwork, group discussion, and problem-solving take place in a classroom environment [3,4]. In other words, lesson time is reserved for the activities such as homework, projects, and group discussions whereas lecturing is moved out of the classroom. Owing to this flip, valuable classroom time is used more efficiently, offering the students an opportunity to put their knowledge into practice [5,6]. In the flipped classroom method, having examined studied the materials provided by the teacher before the exact face-to-face lesson time; the students are expected to come to the class as being prepared at least in terms of obtaining initial subject matter knowledge. Teachers could have an opportunity via learning management systems to monitor whether and to what extent the students have prepared before the class time.

Regarding the research on flipped classrooms, an increasing number of studies can be found in various fields such as mathematics, information technologies, social sciences, health sciences, and engineering sciences [7]. A common finding was reported by those studies that flipped classroom method could provide teachers and students with advantages in easing learning if appropriate technology and instructional method were utilized. A flipped classroom contains two principal elements: i) self-directed learning through digital technologies outside of the classroom, and ii) collaborative and cooperative learning in the classroom [5]. In classroom, it is aimed to not only increase the interaction between the students and teacher(s) in the lesson but also put students into an environment where they could both elaborate on what have been learnt and get immediate feedback from others [8]. According to [9], the teacher's presence in the classroom is imperative particularly in scaffolding and fostering learning by ensuring necessary aids and guides for challenges, problems and questions students may encounter with. In order for teachers to be able to provide efficient flipped learning experience, [10] suggests such "four pillars of flipped classroom" as flexible environment, learning culture, intentional context, and professional educator.

The flexible environment characteristics of flipped classrooms offer students a flexible time and space that enable them to manage learning process at their own pace. It also offers teachers a digital environment in which they can easily monitor, evaluate, and provide feedback about the learning process of their students. The learning culture component of the flipped classroom is referred to an active learning approach where students create their own culture of learning and self-determine as well as self-evaluate the learning in and out-of-class. With the intentional context element, teachers would spend time and effort in designing and developing the learning the materials, activities, course content, and the learning platform that are compatible with both individual self-paced learning and collaborative learning. Finally, professional educator refers to the changing roles of the teachers from the ones in traditional classrooms to the ones in flipped classrooms where teachers are ought to take more proactive roles in especially providing and creating appropriate conditions for students who are expected to be responsible for managing their own learning process outside of the classroom.

Although flipped classrooms enable students to put their theoretical knowledge obtained prior to the class into a practical knowledge and skills in the class time - which could be considered as an efficient use of class time [11], it should be kept in mind that not every student comes to the class by doing necessary studies and preparation for in-class activities [12]. Teachers' role, in this case, becomes very demanding in encouraging students in their self-regulated learning process.

Self-regulated learning could be quite challenging for students, in particular, considering the Internet with full of social networks, shopping websites, and gaming platforms [13]. They may inhibit effective learning time and distract learners. Students need to develop self-regulatory learning skills to meet the prerequisites of the course before the class starts in a flipped classroom method [14]. [15] defines self-regulatory learning as setting objectives, developing strategies to achieve those objectives, and controlling the gains of the strategies. In other words, self-regulatory learning is defined as the individual's ability to monitor their own learning and organize the behaviors and cognitions in accordance with the learning objectives [16]. According to [17], self-regulated learning is a process that enables learners to transform cognitive skills and resources into academic performance skills. [18] states that self-regulated learning includes such three significant stages as firstly, observing the self or behavioral monitoring, secondly, one's evaluation of self-progress, and thirdly, self-activating that involves both emotional and concrete repercussions. According to [18], if one of the three stages were missing, the individual would have difficulty in reaching the objectives set by the self.

Students are subject to using a series of strategies in completing the self-regulatory learning processes such as goal setting, monitoring the learning process, self-evaluation, and time management [19,20]. Students' self-regulatory learning (SRL) skills are important in flipped classrooms [21]. Students with low SRL skills will possibly fall behind the others in the classroom since they do not adequately be prepared before the lesson. In addition, these students might have problems in the classroom activities, for instance, being incapable of completing the activities on time and thus losing interest in and dropping out the course as a result.

21st century skills, namely, problem solving, creativity, algorithmic thinking, and computational thinking that individuals need to be equipped with could be acquired through computer programming instruction [22,23]. Learning programming has always been a challenging subject in information technologies education. Programming instruction is considered to be difficult by many students since it requires higher-order thinking along with abstract concepts and knowledge of rules unique to programming language and debugging [24].

It is assumed that flipped classroom that supports self-regulatory learning process foster students with limited programming knowledge and experience in a programming language. Moreover, it is assumed that students coming to the lesson with the responsibility of their own learning will have an impact on their achievement in computer programming. In this study, we aimed to focus on a self-regulated learning in a computer programming course and students' academic achievement through a flipped classroom method. Hence, this study is aimed to compare the academic achievement of students in programming language course offered through flipped classroom method with those offered through traditional programming language course. The study is also aimed to investigate the relationship between the factors affecting students' self-regulatory learning skills and their academic achievement levels in a programming language course via flipped classroom. The investigation of the factors affecting the students' achievement levels in a practice-based flipped classroom will potentially guide the teachers and practitioners in terms of designing a successful flipped classroom learning environment. Moreover, the study is considered as noteworthy for future studies and practices related to the flipped classroom method to be used in programming language courses.

This study investigates the following questions:

1- Is there a statistically significant difference between the flipped classroom method and the traditional teaching method practices in the programming language courses in terms of students' academic achievement?

2- Is there a statistically significant difference between the sub-dimensions (self-efficacy, anxiety, interactive learning environments, satisfaction, usability, and self-regulatory learning) affecting the self-regulatory learning skills and the student achievement in the flipped classroom method?

2. Method

2.1. Research Model

In this research study, the pre-test post-test control group quasi-experimental design was preferred for the academic achievement variable, and the correlation between self-regulatory learning skills and academic achievement was examined. Designs that aim to determine the differences and cause-effect relationships between variables are experimental research designs [6]. Individuals in the experimental and control groups could

not be randomly assigned in the study; instead, groups were assigned to the groups with an objective selection based on pre-test results. In such cases where the individuals in groups could not be randomly selected, the assignment of the participants following certain measurements is referred to as the quasi-experimental design [25]. While the experimental group was introduced to the flipped classroom method, the control group participants were administered a traditional teaching method. An achievement exam was developed and conducted at the beginning and in the end of the course. In addition, at the end of the treatment, the Self-Regulatory Learning Scale was administered to the experimental group.

2.2. Participants of the Study

Convenience sampling method was used in this study. The sample of the study consisted of students (n=252) attending a vocational college who were studying Electronic Communication Technologies in nine separate branches. The experimental group involved 194 students from seven classes whereas the control group included 58 students from two classes.

2.3. Data Collection Tools

Students can take the Military Student Candidate Exam of the National Defense University in the year they graduate from high school. Students who pass the exam naturally have a certain amount of knowledge that is close to each other. In addition, students are also subject to physical assessments (e.g., age, weight and height) in their selection. Thus, the homogeneity of groups in terms of these dimensions could be considered the same.

2.3.1. Achievement Exam

The practice-based achievement exam developed by the researchers involved 6 questions that aimed to determine the programming language skills of the students (see Figure 1). Opinions of three lecturers working in the department of computer technology were collected for ensuring the content validity of the exam. The exam was administered to all students in the experimental and control groups before and after the 9-week course – programming language course. Each student took the 60-minute exam in computer laboratories. Students were asked six questions related to the programming language. More specifically, the achievement exam involved such questions as follows:

- using the data entered in the textbox object by assigning it to the print function of the button object; printing the addition, subtraction, multiplication and division operations of the numbers entered in the text box on the relevant buttons and the result on the Label,
- checking if the result is negative or positive,
- calculation of the course grade points entered in the Textbox (10% from midterm1, 30% from midterm2, and 50% from final exam),
- using checkbox (if there is a project, adding 10 more points to the average) and checking the result and printing the result,
- using the Radiobutton object and processing the entered data with different mathematical formulas (When the button is clicked, the double, square and cube of the number entered in the Textbox are calculated),
- using the Listbox and Messagebox boxes.

Figure 1. Sample image of the program that students are expected to develop at the end of the Achievement Exam

2.3.2. Self-Regulatory Learning Scale

The Self-Regulatory Learning Scale developed by [1] was used in the study. The Self-Regulatory Learning Scale consists of six factors and measures the sub-dimensions of self-efficacy, anxiety, satisfaction, usefulness, self-regulated learning and interactive learning environments. The scale was adapted to Turkish. The scale was first translated into Turkish by the researchers. Then, the translated version was examined by two lecturers working in the department of foreign languages-English and necessary corrections were made. Later, in order to determine the degree of compatibility of the scale, which was translated from English to Turkish, the opinions of three faculty members working in the foreign languages department were consulted. In order to evaluate the compatibility of the translation with the Turkish language, the opinions of two Turkish language instructors were taken. The Turkish translation of the scale was translated back into English by three lecturers working in the department of foreign languages. In addition, an inversion form was applied between the original English items and the English translation of the scale, and its semantic suitability was graded. The prepared Turkish form was re-examined in terms of meaning and language structure, and the final version of the scale was created.

According to the confirmatory factor analysis (CFA) results applied for the degree of agreement of the factor structure of the scale with the obtained data (=531.53, df= 388, RMSEA = .04, CFI= .97, GFI=.88 , AGFI=.85, NFI=.89 and TLI=.95), show that the model-data fit is very good (Schumacker & Lomax, 1996; Sümer, 2000; Tabachnick & Fidell, 2001). Cronbach Alpha value was calculated to determine the reliability of the scale. It was determined that the internal consistency coefficient of the 30-item scale was .929 and the item-total correlations of the items ranged between .17 and .72. The internal consistency coefficient of the first factor was .865; .874 for the second factor, .851 for the third factor; the fourth factor is .850; it was determined that the fifth factor was .914 and finally the

sixth factor was .905. It can be claimed that the determined internal consistency coefficients are at an acceptable level for the reliability of the 30-item (α >.70) scale [6].

2.4. Structure of the Course Portal

The research was carried out with the second-year students of the programming language course at the department of Electronics Communication Technology. The purpose of this course is to develop students' algorithmic thinking and problem-solving skills, and equip them with the principal knowledge of programming. The course portal, which serves in the intranet environment, was established in 2012 by the Computer Technology Department. The portal provides courses for all departments in the college. Various instructional materials such as videos, presentations, study questions, and information notes of the Programming Language course were given over the course portal. The general structure of the course portal was shown in the Figure 2 below.

At the beginning of the semester, course materials (e.g., videos, sample applications, auxiliary resources) were uploaded to the course portal made available to students.

2.5. Implementation

The Programming Language course lasted 3 hours a week for 16 weeks. Midterm exams were held in the 8th week of the term, and the final exam was held in the 16th week. In the first 5 weeks of the study, all students in the control and experimental groups were taught subjects on algorithms and flowcharts in order to establish the logic and basics of programming. Experimental study continued for 9 weeks with the applications made in Visual C# Programming Language starting from the 6th week of the course. From the sixth week, the traditional teaching method was carried out with the control group students, and the flipped classroom method was carried out with the experimental group students (see Table 1).
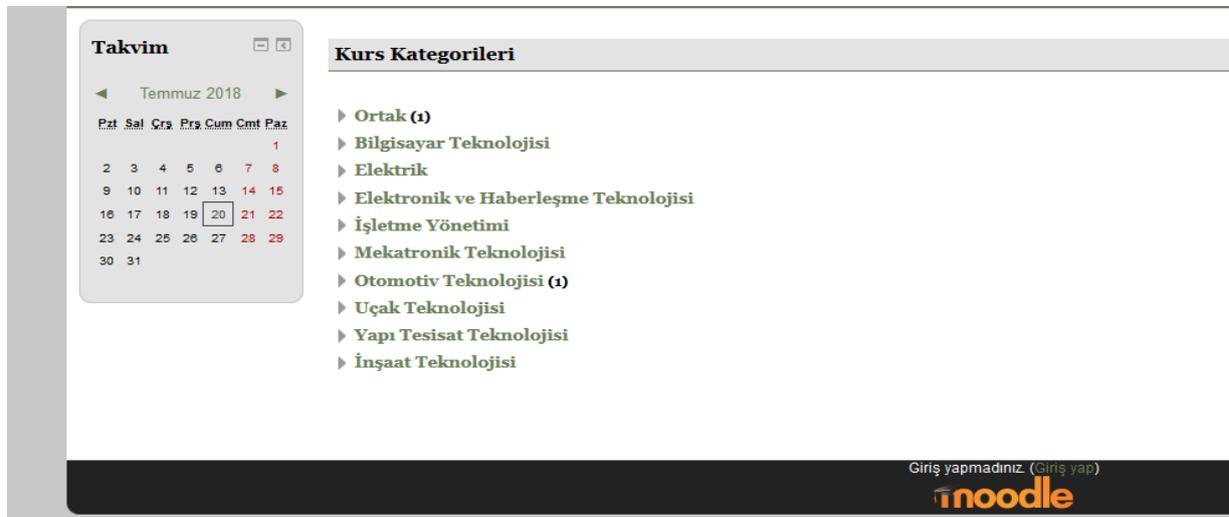

Figure 2. The general structure of the course portal

Table 1. Weekly course topics and implementation process

Weeks	Topics	Teaching Method	Groups
1-5	Algorithm and Flow Diagram	Traditional Teaching Method	Control and Experimental Group
6-15	Introduction to Visual C# .NET An Overlook at Visual C# .NET Menus and Tool Bars Data Types and Variables Decisional Structures Loops	Traditional Teaching Method Flipped Classroom Method	Control Group Experimental Group
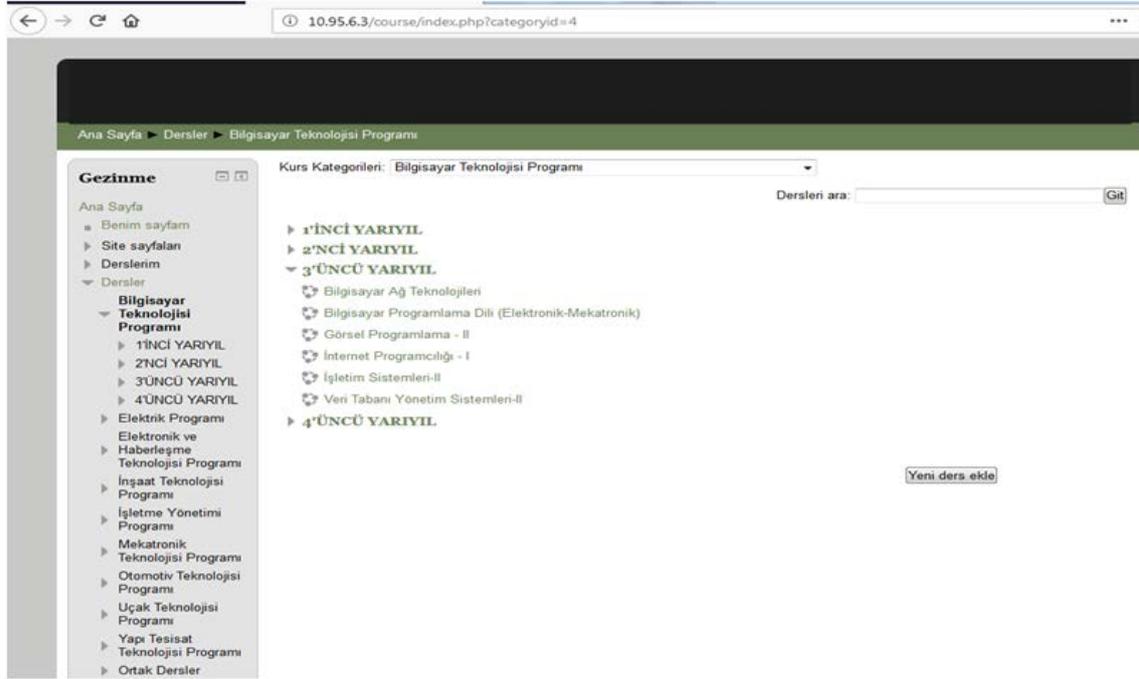
Figure 3. Log in screen for the course portal
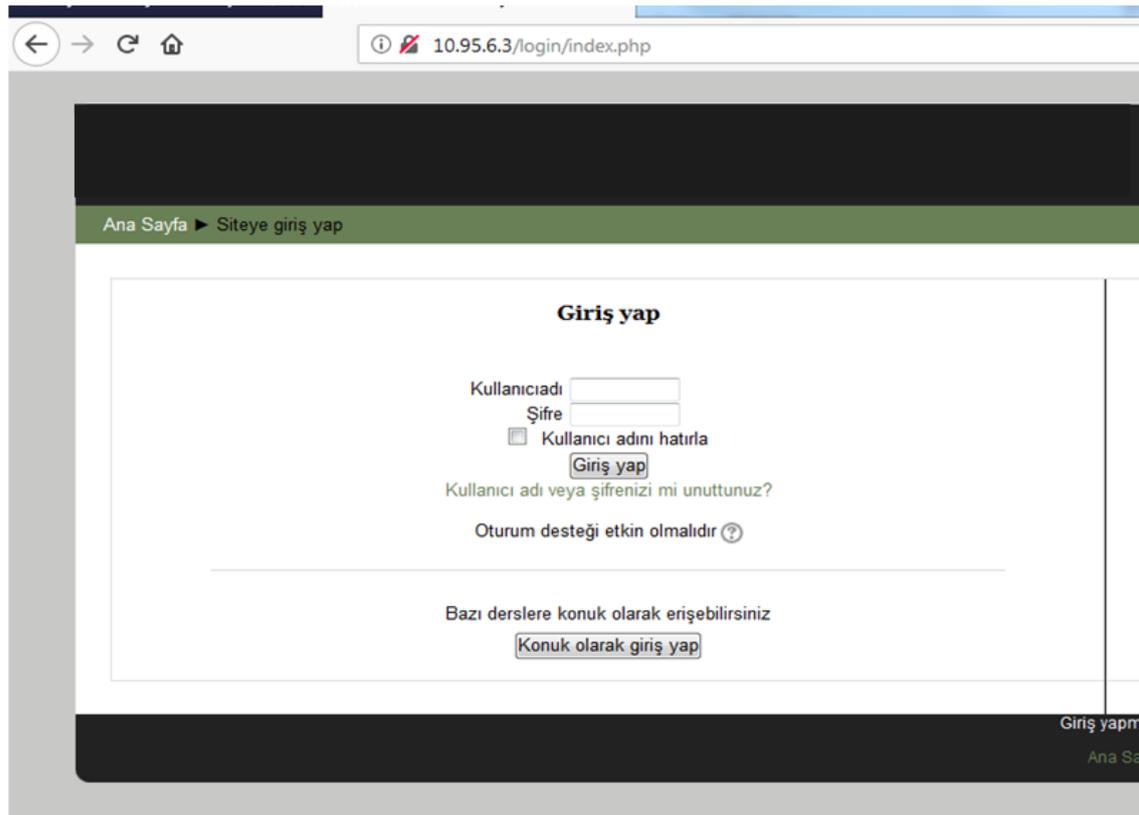
Figure 4. The screen image of programming language course on the portal
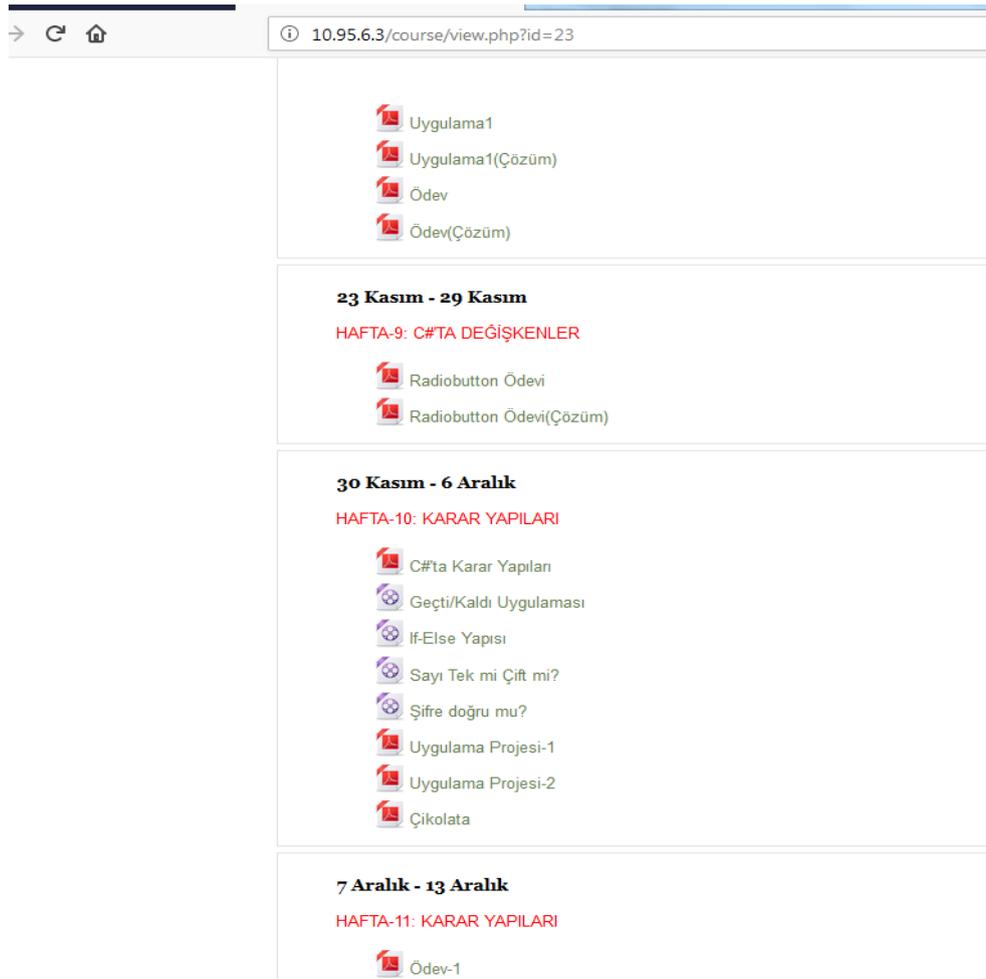
Figure 5. Content of the programming language course

In order to enable all students and academic staff working at the school to access the course portal, an integration has been achieved between the user names and passwords in the Windows session and the course portal. Thanks to this process, Windows login users can log in to the course portal with their name and password from the field in Figure 3.

In the study, all students in the control and experimental groups participated in the Programming Language course created on the course portal. Students could see all department courses within the scope of the Computer Technologies Program on the course portal and can access the course in the 3rd semester (see Figure 4).

Weekly course materials such as course videos, presentations, study questions and information notes prepared by the researcher were uploaded on the course portal. A part of the course content can be seen in Figure 5.

In the 6th week of the lesson, the students in the experimental group were given information about the process of the 9-week course and its activities for adaptation to the flipped classroom method. Students were notified that their responsibilities have changed and that they should be ready for the lesson especially before the lesson.

Students were provided with the opportunity to benefit from computer laboratories in extracurricular times. This was particularly important for the students in the experimental group to complete the off-class activities. In the flipped classroom method applied to the experimental group, the students were encouraged to do the necessary studies for the course materials provided before the lesson. As a result of these preparations by the students before the course, it was ensured that the theoretical part was carried out outside the course. Thus, activities such as programming practices, discussion, and question-answer were carried out in the classroom.

The control group students studied the theoretical part of the course (with the weekly course materials on the course portal) through the traditional teaching method. Activities with program software applications were carried out outside the classroom within the scope of assignments. 7 to 10-minute lecture videos prepared weekly by the researchers were created using the Camtasia software. An example for the practice video is shown in Figure 6.

During out-of-class times, all students could submit their questions to the instructor through the inquiry section of the course portal. All students taking part in the study could send the homework over the portal to the instructor within the specified time frame. All activities performed by the students were kept on the course portal as registration logs, which can be examined by the instructor. During the 9-week course, 13 different practices of programming languages were implemented. Some examples of practices are shown in Figure 7.
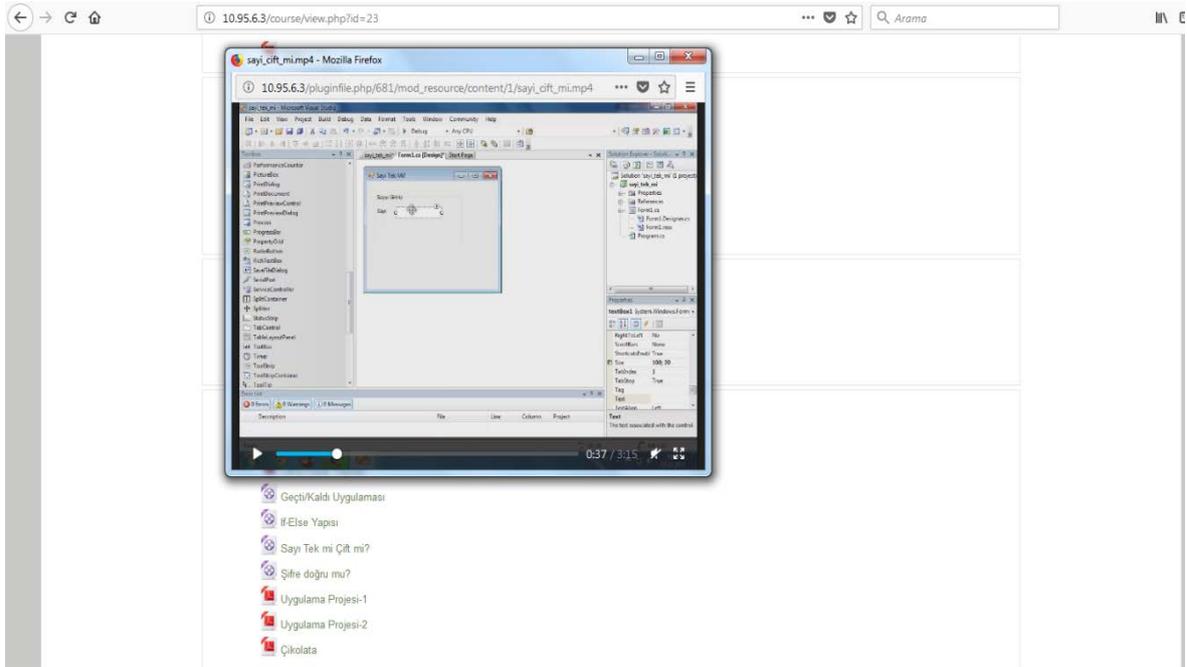
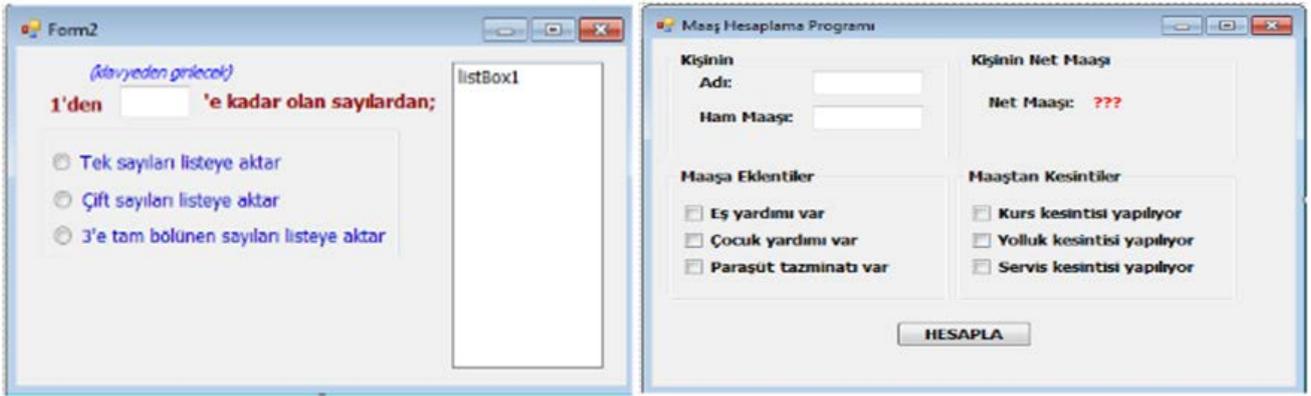**Figure 6.** Screenshot of the practice video

Figure 7. Examples for practices

At the end of the practice process, all students were administered an achievement test. Moreover, the students in the experimental group that studied in the flipped classroom were administered the Self-Regulatory Learning Scale.

2.6. Data Analysis

The data obtained in the study were analyzed with the SPSS for Windows 22.0 program. The equivalence of the students in the experimental and control groups was determined before the practice. At the end of the course, the achievement test was re-administered to determine whether there was a statistical difference between the academic achievement level of the control and experimental group students, and the obtained results were analyzed with an independent samples t-test. Furthermore, a correlation analysis was run to examine the relationship between the academic achievement and self-regulatory learning skills of the students in the experimental group.

3. Findings

Independent samples t-test was conducted to analyze the difference in achievement test scores of students between the flipped classroom method and the traditional teaching method in the programming language course. The findings regarding the achievement test scores of the groups are given in Table 2.

Table 2. Independent samples t-test results: Experimental and control group programming language achievement test scores

Groups	N	X	SS	SD	t	p
Experimental Group	194	79.2	12.45	250	-3.004	.003
Control Group	58	73.3	14.94			

As a result of the comparison of the achievement test results obtained in the Programming Language course, a statistically significant difference was found in favor of the achievement test results of the flipped classroom method (t(250)= -3.004, p<.05). It was determined that the

achievement test results of the group studying with the flipped classroom method (M=79.2) were higher than the achievement test results of the group studying with the traditional learning method (M=73.3). This finding can be interpreted as the programming language course given with the flipped classroom method has a significant effect on the achievement test.

In the flipped classroom method, the relationship between the sub-dimensions (self-efficacy, anxiety, interactive learning environments, satisfaction, usefulness, and self-regulated learning) that affect self-regulated learning and student achievement was examined and the findings were presented in Table 3.

Table 3. Results of the relationship between programming language achievement and factors affecting the self-regulatory learning skills of the experimental group students

		Self-efficacy	Anxiety	Interactive Learning Environment	Satisfaction	Usability	Self-Regulatory Learning
Achievement	r	.642	-.730	.753	.755	.594	.698
	p	0.000	0.000	0.000	0.000	0.000	0.000
	n	194					

As seen in Table 3, a positive and significant relationship between the achievement test results and self-efficacy, interactive learning environments, satisfaction, usability, and self-regulatory learning dimensions of the Self-Regulatory Learning Scale, while a negative and significant relationship was found with the anxiety sub-dimension. In other words, students' self-regulated learning skills, self-efficacy, satisfaction in the learning environment, finding the learning environment useful and interacting with the learning environment increase, the success of the students increases. In other words, students' self-regulatory learning skills, self-efficacy, satisfaction with the learning environment, students' consideration of the learning environment as useful, and their active interactions with the learning environment play a significant role in increasing students' academic achievement. On the contrary, it was determined that as students' anxiety about the learning environment increased, their success decreased. When the relationship between students' course achievement and sub-dimensions was examined, it was determined that the highest relationship was in the satisfaction sub-dimension, and the lowest relationship was in the usefulness sub-dimension. In other words, the success of the students in the course was affected by the satisfaction in the learning environment the most, whereas it was affected by the usefulness of the learning environment the least.

4. Conclusion and Recommendations

Many educational institutions in various courses use the flipped classroom method. In this method, teachers share the materials they have created about the subjects of their lessons with their students online, students come to the lessons by examining these materials during extracurricular times, and they have the opportunity to practice more during class time [12]. While the flipped teaching method can be effective in all courses, it can be said that it is more effective especially in courses that require laboratory work and projects [26]. The reason for this is that students do not have laboratories facilities at home nor do they have advanced computers to do some specific projects. Especially due to the complex nature of programming language courses [27] and students' lack of sufficient programming practice, their academic success is not at the desired level [28].

In addition, students' self-regulated learning skills allow them to actively participate in the learning process and enable them to manage their own learning [19]. Many studies have been conducted to determine the positive contribution of students' self-regulated learning skills on their academic achievement [1,29,30].

For this reason, it is very important to teach the Programming Language course with the flipped classroom method, where students can do more project activities and practices, and to examine the effect of students' self-regulated learning skills on academic achievement in this process. In this study, the success of the experimental group working with the flipped classroom method in a Programming Language course offered in a Vocational College was compared with the success of the control group working with the traditional classroom method. In addition, the relationship between the self-regulated learning skills of the experimental group students and their academic achievement was examined. Since the research on the flipped classroom method generally included studies sharing the ramifications of personal experiences, the findings of this experimental study are quite significant.

When the achievement scores of the Experimental Group trained with the flipped classroom method and the control group trained with the traditional classroom method were compared, it was seen that the experimental group was significantly more successful. This finding is similar to studies that claim that the flipped classroom method has a positive effect on students' academic achievement, class participation and motivation compared to the traditional classroom method [11,31-45]. However, there are studies in the literature that did not find a difference in terms of student achievement and motivation in the traditional classroom and the flipped classroom method [12,46,47]. Moreover, there are also studies in which students were not satisfied with the flipped classroom method because too many activities were done [48].

As a result of the study, it was revealed that delivery of the related resources by the lecturer outside the classroom time and the allocation of the class time for the activities directed at practice contributed to the achievement. As a result of the study, it has been revealed that theoretical learning resources related to the course topics were provided during out-of-class time and in-class time is spent only with practical studies contributes to the success. Considering the self-regulatory learning skills thought to affect the achievement of the vocational college students in the flipped classroom method, a positive and statistically significant correlation was found between self-efficacy, interactive learning environments, satisfaction, usefulness, and self-regulatory learning skills and achievement scores. This finding obtained from the study is similar to the results of studies in the literature that

found that self-regulated learning skills in online courses are positively related to students' success [1,29,30,49-56]. Contrary to this, [57] did not find any significant relationship between students' academic achievement and self-regulated learning skills in a related study. According to the results of the research, the development of the self-regulatory learning skills of the students has crucial importance for the success of students in not only the traditional classroom method but also the flipped classroom method. Thus, enriching the self-regulatory learning skills of the students and improving their interaction with the lesson environment can positively impact their success.

A moderate, positive and statistically significant relationship was found between students' self-efficacy perceptions and course achievement. The result obtained from the study is similar to the results of studies claiming that self-efficacy perception affects success positively [58,59]. Additionally, in studies emphasizing that students with high self-efficacy perceptions have a greater desire to study, thus their course success is higher [60,61]. On the contrary, the results of the present study differed from the results of the studies conducted by [62] and [54]. [62] revealed that the self-efficacy perception of the participants in online courses was a weak indicator for success. Similarly, [54], in a study carried out at the undergraduate level, determined that there was no statistically significant correlation between self-efficacy and students' achievement.

In this study, a negative and statistically significant correlation between perceived anxiety and achievement was found. This finding showed similarities with the studies that found negative and statistically significant correlations between anxiety and academic achievement [63,64,65,66]. Additionally, there are studies in the literature revealing that test anxiety was an important predictor for academic achievement [67,68]. Regarding the research on online environments, [69] found a negative and statistically significant correlation between perceived anxiety and self-regulated learning skills of the students in online environments. Besides, it was deduced that perceived high anxiety negatively impacted student performance in traditional learning environments.

Interactive learning environments are significant predictors in developing perceived environmental satisfaction, perceived usability, and self-regulated learning skills of the students in online environments [70,71]. In this study, a moderately positive and statistically significant correlation was found between satisfaction perceptions and course success of the students. This result is similar to the studies that determined that students with high satisfaction perceptions are more successful in their online courses [54,55]. In addition, it supports studies that indicate that students' perception of satisfaction is an important factor for successful learning [52,72,73]. Moreover, students' perceptions of usefulness may be an indicator of their perception of satisfaction with the online learning environment [74].

A moderate positive and significant relationship was found between students' perceptions of usefulness and their course achievement. The result obtained is similar to studies that found that the perception of usefulness positively affects students' academic success and satisfaction perceptions [74,75,76]. In addition, [77]

suggested that perceived usefulness is one of the strongest factors for success. Furthermore, several studies [78,79,80] stated that perceived usefulness played a significant role in an individual's acceptance of an information technology system.

The educators aiming to implement the flipped classroom method should be equipped with adequate skills in computer and Internet technologies, in particular, designing and developing digital learning materials for online environments as well as the out-of-class activities. Lecture videos are one of the critical tasks by instructors in flipped classroom method; hence it should be considered that creation of those videos could take more time. Presenting videos is not important but ensuring and motivating students to watch those before in-class activities is crucial. Concerning this, the teacher could administer a weekly quiz at the beginning of each lesson.

This study investigated the correlation between factors affecting the self-regulatory learning skills and the academic achievement of the students in the Programming Language course designed with the flipped classroom method. The flipped classroom method could be employed in different theoretical or practice-based courses to investigate the potential results.

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