Case Study Analyses of the Impact of Flipped Learning in Teaching Programming Robots

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***Abstract*— The focus of the research study was to investigate and find out the benefits of the flipped learning pedagogy on the student learning in teaching programming Robotics classes. Also, the assessment of whether it has any advantages over the traditional teaching methods in computer sciences. Assessment of learners on their attitudes, motivation, and effectiveness when using flipped classroom compared with traditional classroom has been realized. The research questions investigated are: "What kind of problems can we face when we have robotics classes in the traditional methods?", "If we applied flipped learning method, can we solve these problems?". In order to analyze all this, a case study experiment was realized and insights as well as recommendations are presented.**

***Keywords*— flipped classroom, programming robotics, effectives of learning, flipped learning paradigm.**

1. Introduction

The technological innovations and different collaboration tools have changed the face of education [2]. Using new technologies, students can organize their learning process independently and become an active learner instead of the passive learner as disscused in [8]. This situation forces the education paradigm to change from traditional instructor-centered to student-centered classroom. Therefore, technology plays a big role in this change by using its various online/offline tools and devices. We have been witnesses that the modern technology plays a significant role in our education system.

Besides, exploitation of robotics in educational processes has dramatically increased recently. According to [1] what makes robotics studies attractive for educationists is that it's of trans-disciplinary and project-based nature which offers "major new benefits in education at all levels." [12] "Robotics uses 21st century technologies and can foster problem solving skills, communication skills, teamwork skills, independence, imagination and creativity". According to [13] using robotics in education as a tool enhances student learning and motivation [12]. Moreover, providing robots for students and schools is easier than before. Many schools in the world have started to implement brick-based robotics classes to develop constructionist learning and student thinking. [13]. This allows children to add computation to traditional construction method [15].

"Robotics is an excellent tool for teaching science and engineering, and it is a compelling topic for students of all ages. However, the art, science, and pedagogy of teaching hands-on robotics is still in its infancy." [14]

Project Based Learning in robotics is a learning strategy that utilizes robot project and creates teams for team working. According to [16] "This learning environment includes all of the robotics development materials. Usage of visual programming and control technologies supports students' discrete learning abilities at school level." In this learning method students ask and refine questions, debate ideas, make predictions, collect and analyze data, draw conclusions, and communicate their findings to others. Thus students learn with all of their capacity and curiosity.

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According to [4] the flipped classroom is a pedagogical method that helps educators to utilize the technology as a tool to increase the quality of the student learning experience as defined by [4]. The basic concept of the flipped learning is to deliver teacher-created short video lectures to students before class time. Students can watch and learn the video content usually at home. In class time, students work on their classwork or homework with instructor's more personalized guidance [10]

Traditional teaching has a limited time to repeat the lecturing in class time. But flipped learning gives the control to students. They can review, replay, rewind, and fast-forward the video as needed [3]. Thus, students feel free to learn the lesson content anytime, and any missed classes can be watched with lower stress repeatedly [7]. That carries the individual learning facilities out of the classroom walls. Also, students come to the class with questions regarding the topics.

The important part of the flipped learning is to convert the class time into a time to discuss deeper questions about the topic and student-teacher can work together to engage in collaborative learning. Teachers make more efficient use of the class time [5]. Students can complete classroom activities and get assistance from the instructors. That gives the teachers the role of a learner-facilitator, because [8] explains, "[this] opens more time in class for the teacher to go deeper into a topic which allows students to develop a better understanding of the content, and the students are doing their homework in class where the teacher is available to help if they get stuck."

The flipped learning brings active learning environment to classroom with online course materials. It makes the class time very meaningful for reviewing and applying knowledge. It opens doors to project based activities [3]. This pedagogy also gives opportunity to discuss all the aspects of instructions by students and teachers. On the other hand, it focuses to increase the teacher-student interaction besides learning of the lesson content[6].

2. Aims of the Research Study

The main aim of the research study is to investigate and assess the impacts of the flipped learning model of student learning in the Robotics lessons of the tenth grade students of Karposh Yahya Kemal College in Skopje, Macedonia. The main aim is to compare and asses the differences between the flip learning pedagogy and the traditional learning methods.

The technological improvements have changed many aspects of our life-style. Every aspect of our life has been affected by online services; from reading newspapers to communications [6]. Education as part of our life has also been affected inevitably by these novelties. There are many researches to explore the learning outcomes of the courses that use new technologies in the school curricula and students' response to today's online services. But, almost all such studies were conducted out of Macedonia until today. This study aims to make a small contribution to education in Macedonia.

The second aim of this study is to inform robotics instructors about how much their instruction using the flipped learning methods affects the outcome of their class. The Robotics class is different from other classes. Robotics teachers have compelling reasons to use new educational methods. These reasons are;

- To lecture the theory & practice in short class time, generally one class hour (45 min). In this regard curriculums are weak.
- Some students may not have the chance to use a robot at home. They may have smartphone or tablet simulators but using a real robot is a totally different experience.
- Students are more motivated when learning through robots.
- Robotics classes are based on learning by doing methodology. (Task-based learning, project-based learning) This makes learning deeply rooted. In this methodology students see the results of their work immediately after finalizing the task and learn better.
- Robotics classes can easily be integrated into other school subjects such as mathematics, physics, arts and design etc.
- Robotics studies are by its nature competitive. While students are trying to complete a task in robotics they compete with their peers and when they achieve the task they run their robot and show others their work. This itself gives students the mood of competition which can be very motivating at that age.
- Robotics classes teach students the academic value of computational thinking. While programming a robot, students are obliged to think like an AI considering all possible internal and environmental variables which makes them realize the way sophisticated intelligent machines including the human brain work.

3. Research Methodology

The research study methodology is action research and empirical research. Also, used are quantitative and qualitative methods at the same time using triangulation to determine the results. Participants of this research are divided in three groups of the first grade students of Karposh Yahya Kemal College in Skopje. One of the classes is assigned as a control group, and the other two are assigned as experimental groups. Initially a preliminary survey from all groups

was taken. This survey questions will aim to realize the student's background knowledge of the topics, usage of the internet and other technological devices.
It has utilized the learning management system called Schoology. Each group register into their own online group called "Robotics Course" on Schoology. After registering, students could access the online posted materials in this course. The main materials are high quality recorded topical videos, presentation files, and worksheets. Also, required are some physical tools like such as drives, CDs, tablets, smartphones and computers.
Students will watch the short tutorial videos which will cover the main lesson topics at home. These videos are published on the YouTube. The video length is less than 10 min. Students are able to follow the instructor's lecture along with the video by re-playing or pausing. To be sure that the video is watched by the students, they will have to take some notes on the video contents to present the teacher. Additionally, at the end of each video lecture there is a small quiz to review the student comprehension.
Firstly, within the study reviewed is the video lecture through in-class discussion. Also, the quiz result which is taken before class time will help me to understand how much the topic is covered by the students. Then, if lecturing is necessary, the video can be watched again in 5-10 minutes of the class time. The most important part of this pedagogical model is its power to let us have more face-to-face interaction time with the students to implement meaningful learning activities [11] and [14]. During the activities, I can identify areas of weaknesses in student's comprehension. And, I could explain or discuss the unclear parts of the lecture with the students. These activities will provide me with clues for improving the quality of teacher-student interactions on meaningful student learning [9] and [10]. At the end of the class time the class work is uploaded to Schoology. The flipped classes are 10 lessons during the spring semester of the educational year.
The tests, quizzes and observations are collected and recorded in tables. Also, the final exam and the project result are added to the data tables. Additionally, survey questionnaires and interviews are recorded and transcribed for analysis. This study is quasi–experimental as there is a group of the participants previously separated according to their classes as one control and two experimental groups.

The research target group are the 10th grade students of Karposh Yahya Kemal College. There are 3 different classes with around 20 students each: I-A, I-B and I-C. According to my five-month experience, each class has approximately the same educational background of computer science lessons.

4. Hypothesis and Research Questions

Robotics as a newly emerged school subject promises new learning motivation for students and new pedagogical approaches for teachers. A classroom with robots on desks is sure to excite children for a new learning experience. Besides, the study of robotics allows the teacher to introduce or reinforce many science subjects such as mathematics and physics. While working with robots students are more eager and use their innate curiosity more. But still, this new phenomenon introduces us new challenges to overcome.

The first problem is that, robotics as a school subject is nonexistent in the high school curricula in Macedonia except for a few private high schools. When we include this subject in the curricula we confront with the difficulty of having too few classes per week to teach students enough of the technical data as well as practice. Students need to devote extra time at home to grasp the concept of robotics and to gain the skill of programing.

Secondly, considering the cost of a Lego EV3 set for teaching robotics which is around 500 euros, for the average Macedonian parent it is too much to afford. Hence, the best solution seems to use the robots at school. This makes home practice impossible for students.

Thirdly, robotics practice necessitates a tutor because it requires the programming skill which is hard to achieve without the guidance at the amateur level.

Considering the situation of the high school level robotics classes in Macedonia and the problems mentioned and argumented previously, devised the hypothesis as below.
"The flipped learning model has a positive impact on the student learning in the Robotics classes?"

The research questions are:

- "What kind of problems can we face when we have robotics classes in the traditional methods?"
- "If we applied the flip method, can we solve these problems?"

5. Results

In order to capture the learners' feedback and asses the impact within the research study a questionnaire was used and devised. There were 54 participants that filled in the questionnaire. The results are given below.

Figure 1. Results from assessing the methodology and approach undertaken

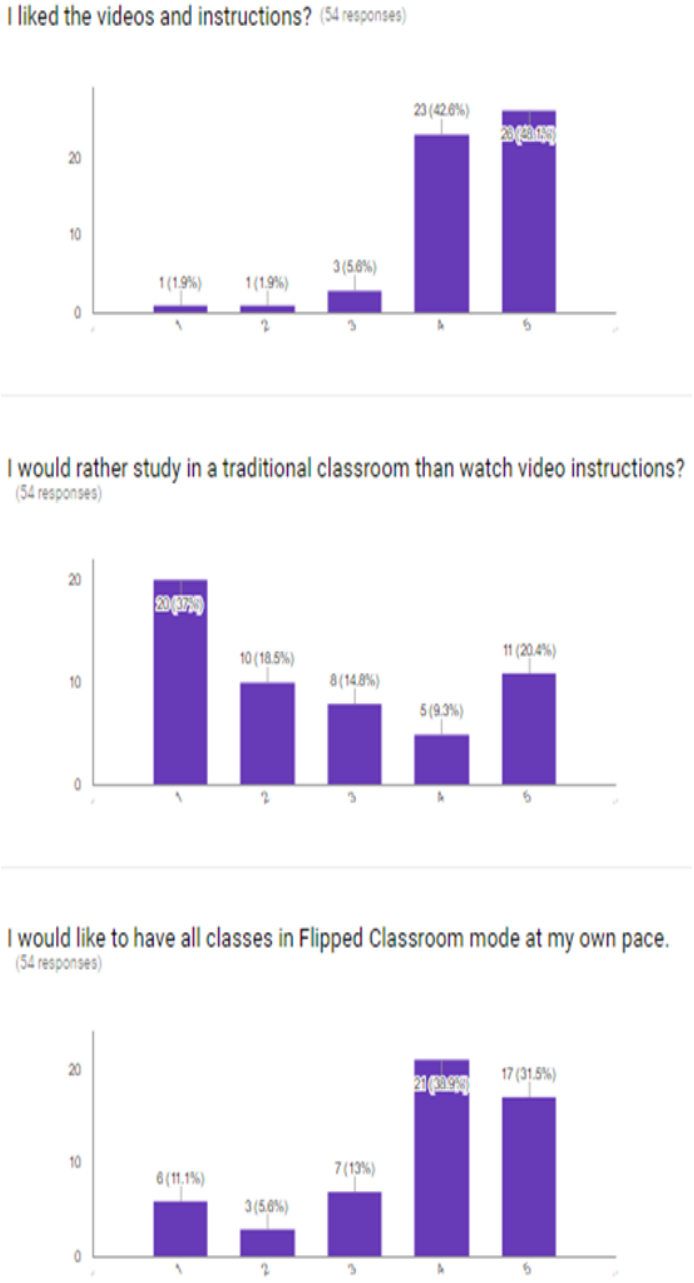
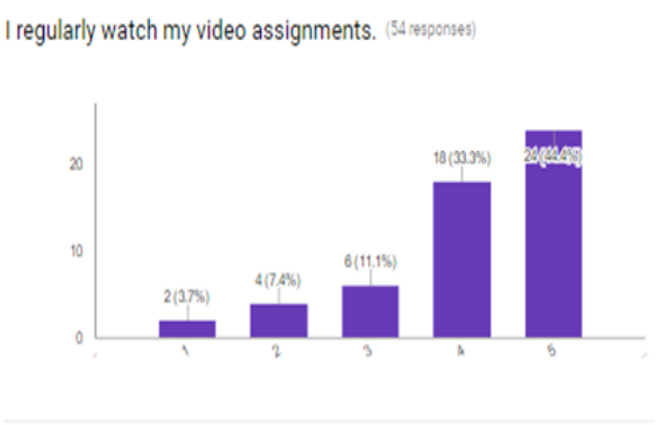
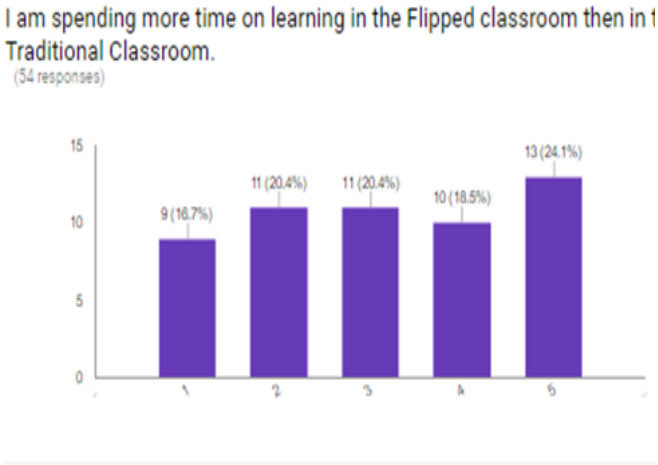


Figure 2. Results from assessment of participants on their attitudes





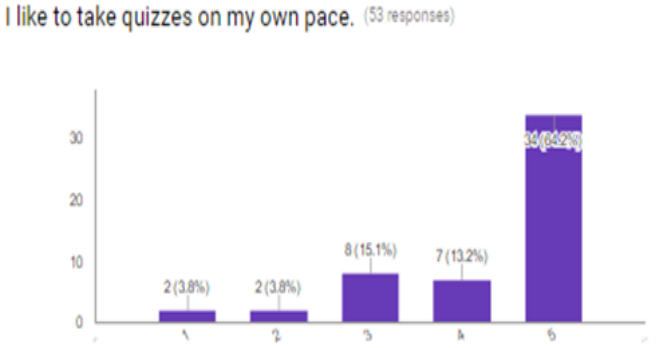


Figure 3. Results from assessment of participants on their motivation

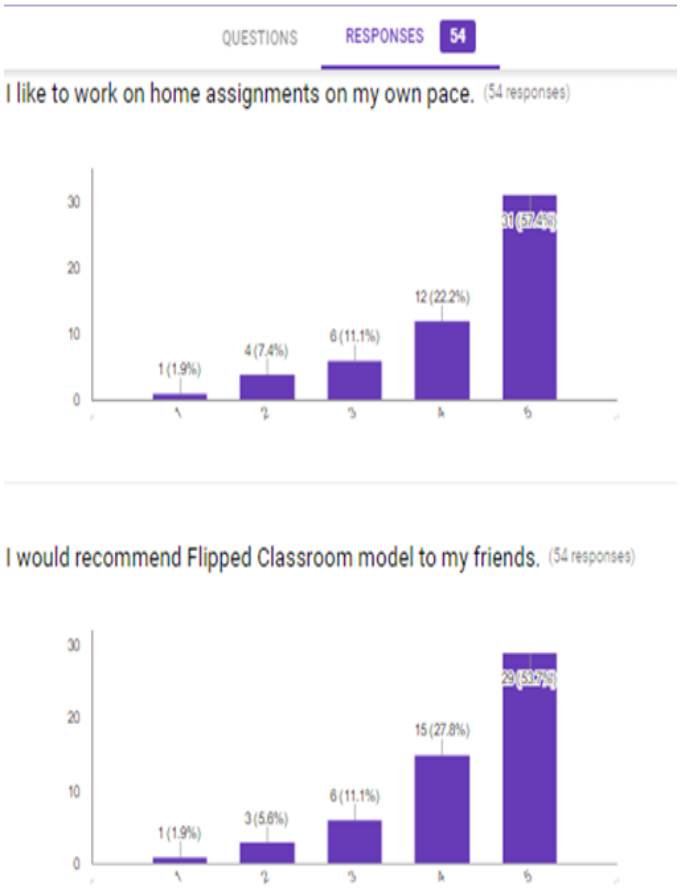


Figure 4. Results from the impact of internal factors

6. Conclusions

The research study aims was to investigate and find out whether there is any benefit of the flipped learning pedagogy on the student learning in the Robotics lessons and whether it has any advantages over the traditional teaching methods in the computer science lessons. Based on the learners feedback we can conclude that the integration of technology into classroom instruction can improve the student motivation considerably especially for the extrovert and reflective learners who benefit mostly from flipped classroom.

Figure 5. Students practicing their programming skills

Another importance of this research study is that it may help educators to realize that teacher-student integration is possible to be improved in class time by class activities. Because, doing homework or class work in class time together provides a teacher with communication opportunities with their students [14]

Students sometimes learn from online video channels themselves. They follow the people who are commonly titled as YouTubers who create and upload videos frequently [5]. For example, some YouTubers create a video series to instruct the programming languages chapters respectively. Students can subscribe to the channel and get involved in the online video lessons. Taking benefits from this addiction, the Flipped learning may fill out the teacher-student gaps by online course materials and communications.

As an educator, especially a computer science teacher, we should guide our students on how to use their computers and mobile devices in educational ways. Sometimes, they lose plenty of their time using the internet unconsciously. They cannot focus on their assignments and subjects adequately. This pedagogy, with teacher-student interactions, may help students to use their precious time properly.

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