THE EFFECTIVENESS OF PRIMM-FLIPPED CLASSROOM TOWARDS CRITICAL THINKING SKILLS, MOTIVATION AND ACHIEVEMENT IN LEARNING COMPUTER PROGRAMMING COURSE AMONG UNDERGRADUATE STUDENTS

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ABSTRAK

Flipped classroom ialah pendekatan popular untuk meningkatkan pembelajaran pendidikan tinggi, termasuk pengaturcaraan komputer. Mempelajari konsep pengaturcaraan dan asasnya adalah tugas yang sukar bagi sesetengah pelajar, mengakibatkan pencapaian akademik yang lemah dan keterasingan. Pengaturcaraan komputer memerlukan kemahiran berfikir kritis, yang tidak dimiliki oleh pelajar sarjana muda di Palestin. Akibatnya, terdapat keperluan untuk menggunakan kaedah yang sesuai untuk memperibadikan pembelajaran. *Flipped classroom* adalah penting dalam pembelajaran pengaturcaraan komputer kerana ia menjadikan subjek lebih menarik. Terdapat jurang dalam kajian penyelidikan yang dijalankan di universiti-universiti di Palestin mengenai keberkesanan pembelajaran *flipped* dalam pembelajaran pengaturcaraan komputer. Kajian ini menyiasat dan menghuraikan kesan *flipped classroom* dalam pembelajaran pengaturcaraan komputer terhadap kemahiran berfikir kritis, motivasi dan pencapaian dalam kalangan pelajar di Palestin. Topik tersebut penting kerana ia berpotensi untuk menambah baik proses pembelajaran pengaturcaraan di universiti. Reka bentuk mod campuran menggunakan kedua-dua pendekatan kuantitatif (Kuasi-eksperimen) dan kualitatif (Temu bual). Sampel kajian termasuk 123 pelajar sarjana muda dari Palestine Technical University Kadoorie di Palestin. Pelajar

dibahagikan kepada dua kumpulan: *flipped classroom* (kumpulan eksperimen) dan *non-flipped classroom* (kumpulan kawalan). Kajian ini menggunakan Ujian Kemahiran Pemikiran Kritikal California, Soal Selidik Motivasi Pengaturcaraan, dan Ujian Pencapaian Pengaturcaraan, sebagai tambahan kepada pendekatan kualitatif yang menggunakan kaedah temu bual untuk pelajar (9 pelajar) yang mengambil bahagian dalam intervensi. Min, sisihan piawai, dan ujian-t bebas dan bersandar digunakan untuk keputusan kajian. Temu bual dianalisis menggunakan program NVIVO. Keputusan menunjukkan perbezaan yang signifikan secara statistik dalam kemahiran berfikir kritis, motivasi, dan prestasi pengaturcaraan antara kumpulan kawalan dan eksperimen yang memihak kepada kumpulan eksperimen. Pada masa yang sama, kajian ini mendapati korelasi positif yang lemah antara kemahiran berfikir kritis pelajar, motivasi, dan pencapaian dalam pembelajaran pengaturcaraan C++ komputer. Ini boleh menjadi asas kepada penyelidik masa depan untuk menyiasat hubungan antara kemahiran berfikir kritis, motivasi, dan pembelajaran pengaturcaraan C++ komputer. Di samping itu, temu bual dengan pelajar prasiswazah mendedahkan bahawa *flipped classroom* mempunyai kesan positif terhadap kemahiran berfikir kritis mereka dan mendorong mereka untuk belajar. Kajian ini menyediakan garis panduan yang berguna kepada pensyarah untuk menjalankan penyelidikan jenis ini menggunakan model ADDIE. Selain itu, gunakan pendekatan PRIMM untuk struktur dan aktiviti reka bentuk kelas. Kajian lain perlu dijalankan untuk menunjukkan kesan flipped classroom dalam pembelajaran pengaturcaraan ke atas kemahiran lain seperti pemikiran kreatif dan kecekapan pengaturcaraan.

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ABSTRACT

The flipped classroom is a popular approach for improving higher education learning including computer programming. Learning the concept of programming and its foundation is a difficult task for some students, resulting in poor academic achievement and estrangement. Computer programming requires critical thinking skills, which Palestinian undergraduate students lack. As a result, there is a need to use appropriate methods to personalise learning. The flipped classroom is important in computer programming learning because it makes the subject more interesting and appealing. There were gaps in research studies conducted in Palestinian universities concerning the effectiveness of flipped learning in computer programming learning. This study investigates and describes the effects of flipped classroom in learning computer programming towards critical thinking skills, motivation and achievement among undergraduate Palestinian students. The topic is important because it has the potential to improve the programming learning process in universities. A mixed-mode design employs both a quantitative (Quasi-experimental) and a qualitative approach (Interviews). The study sample included 123 undergraduate students from Palestine Technical University Kadoorie in Palestine. The students were divided into two groups: flipped classroom (experimental group) and non-flipped classroom (control group). The study applied the

California Critical Thinking Skills Test, the Programming Motivation Questionnaire, and the Programming Achievement Test, in addition to a qualitative approach employing the interview method for the students (9 students) participating in the intervention. Means, standard deviations, and independent and dependent t-tests were used to show up at the study's results. The interviews were analysed using the NVIVO programme. The results revealed statistically significant differences in critical thinking skills, motivation, and programming performance between the control and experimental groups in favour of the experimental group. Simultaneously, this study finds a weak positive correlation between students' critical thinking skills, motivation, and achievement in learning C++ computer programming. This can serve as a foundation for future researchers to investigate the relationship between critical thinking skills, motivation, and learning C++ computer programming. In addition, interviews with undergraduate students revealed that the flipped classroom had a positive effect on their critical thinking skills and motivated them to learn. This study provides lecturers with a helpful guideline for conducting this type of research using the ADDIE model. Additionally, use the PRIMM approach to structure and design class activities. Other studies should be conducted to demonstrate the effect of the flipped classroom in programming learning on other skills such as creative thinking and programming competence.

CHAPTER 1

INTRODUCTION

1.1 Introduction

The 21st century has led to rapid technological transformation, which shrank the vast world into an interconnected global village (Malik, 2018). The digital revolution has impacted education systems as the rise of the Internet and Information Communication Technology (ICT) made personal computers (PC), smartphones, and social media part of the teaching and learning experience. According to Leveaux et al. (2019), the present education system is now inextricably intertwined with technology, whether through teaching with smart boards, smartphones, or even social networks, prompting educators and students to incorporate their advancements in the teaching and learning process.

ICT in education is used when designing or implementing online programmes, whilst the introduction of flipped classrooms integrate existing online modules with conventional face-to-face learning (Powell et al., 2015). Flipped learning, which combines online web resources and live classroom interactions, attempts to overcome a wide gap between online and traditional teaching and learning methods (Awatale & Arts, 2020), and considered one of the teaching and learning strategies popularly incorporated in higher education (Bishop & Verleger, 2013).

According to Gilliland (2017), a flipped classroom is one in which the teacher provides knowledge services such as images or basic tasks prior to teaching. Class time could well be devoted to more complex activities and higher-level thinking. The flipped classroom adopts a student-centred approach and offers more chances for active learning

in the formal classroom setting (Hibbard et al., 2016). Teachers do not just disseminate knowledge; instead, they can initiate group discussions and peer-to-peer sharing. Teachers can make the most of the time allotted to learner by displaying and building individual instances. During the learning phase, the learners will be supervised in smaller classes by collaborating to solve challenges using previously acquired basic skills. Students can then apply, assess, calculate, execute, construct, and debate course details while also improving their practical and social skills (Long et al., 2016). Consequently, the motivation for employing flipped learning is to accommodate the changing requirements and interests of 21st-century students equipped with a wide range of technological communication tools (Awatale & Arts, 2020).

According to Mcbride (2015), because they are student-centred, flipped classrooms enable active learning techniques in which teachers scaffold students to use higher-order thinking skills. Unlike traditional lectures and assignments, flipped classrooms are conducted in reverse, with students being assigned to watch short video lectures at home prior to class to gain content knowledge. The allocated learning session would be dedicated to cognitive higher activities including problem-solving, group projects, and discussions, etc (Zainuddin & Halili, 2016). Integrating ICT into classrooms guarantees that students are taught utilising new technology-based teaching and learning methods and facilities (Ghavifekr & Rosdy, 2015).

Flipped classroom considered novel learning strategy needed to incorporate in practical and challenging courses in higher education, so applying the flipped classroom approach, particularly in computer programming, allows students to resolve problems, abstract information, think critically, and analytically (Gomes & Mendes, 2007; Topalli

& Cagiltay, 2018). Most importantly, these students would be equipped with skills would help prepare them for their future careers (Topalli & Cagiltay, 2018; Vaca-Cárdenas et al., 2015).

Computer programming is one of the university courses that could benefit from the use of a flipped classroom. As a required subject in many fields of higher education, it is one of the most difficult subjects for educators to teach and for students to understand (Peethambaran et al., 2018; Rahim et al., 2018).To acquire and develop 21st-century skills, programming education is required (Fessakis et al., 2013; Kalelioğlu & Gülbahar, 2014; Gülbahar & Kalelioglu, 2018; Yang et al., 2018**).** There is also a growing demand to learn the basics of coding to become a conversational programmer allowing effective communication with technology experts (Chilana et al., 2015) and to develop digital literacy providing a pathway to engage with new technologies (Lee et al., 2016).

Despite the importance of computer programming, students may become discouraged when learning specific concepts such as syntax, semantics, and coding (Andrzejewska, 2018a; El-zakhem, 2016; Krpan et al., 2015; Malik & Coldwell-Neilson, 2016). They frequently lose motivation when learning to programme because they trust the course necessitates complicated concepts and skills (Shim et al., 2016; Tugun et al., 2017). The negative perceptions towards the course and challenges in learning programming resulted in low academic achievement and high failure rates (Krpan et al., 2015).

When we look at the programming education literature, it can see that many learning strategies and tools have been employed to help students in programming classes.

Some of these techniques that may be found in the literature include algorithm visualization tools, robotic programming tools, web-assisted education, computer-aided education, educational games, gamification, and pair programming. In the current study, the flipped classroom, which has emerged as a novel learning approach integrated with PRIMM structure to plan the In-class activities.

To address issues related to undergraduate students' critical thinking skills, motivation, and achievement in a computer programming course, this study investigates whether flipped classrooms would help enhance the students' ability to learn to program. Karaca and Ocak (2017) indicated that flipped classroom model is an effective way to overcome programming difficulties and improve learning. Furthermore, studies that employed the flipped classroom model reported increased student motivation and learning performance, this model enhanced practice opportunities, immediate feedback, and individualization of reflection in programming training, making learning more fun with multiple online environments (Luo et al., 2014; Hsu & Lin, 2017; Chang et al., 2018; Karampa & Paraskeva, 2018). As a result, the flipped classroom model is regarded as a practical approach to teaching programming.

1.2 Background of Study

Due to the prominence of digital devices and the public's increased desire for software applications in recent years, computer programming is quickly becoming a basic competency for the 21st century civilisation. It was discovered that computer programming might possibly foster critical thinking in students (P. Rusimamto et al., 2019). Although,

it has become a central topic of higher education as part of Science, Technology, Engineering, and Mathematics (STEM) education.

In Palestine, computer programming is not taught at the high school level; consequently, students lack foundational knowledge (Demaidi et al., 2019). As programming is a new area for university students, they must spend a great deal of time solving programming problems, which classroom sessions cannot fully support.

To acquire programming concept and build proficient programming abilities, one must learn to derive the algorithm from the requirements and then convert the algorithm into software code using the syntax and semantics of a specific language. To do this, a learner must begin with basic problems and programming assignments and eventually progress to more difficult problems (Winslow, 1996).

Previously, computer programmes were only used for software installation. Nonetheless, with the prominence of social media platforms in various economic-related fields, computer programmers are in high demand, as the income of well-executed social media platforms is equivalent to or even higher than the GDP of some countries (Yurdagül, 2018). Despite the slow pace of transformation, particularly due to a lack of awareness of the Fourth Industrial Revolution (4IR), fresh graduates are widely regarded as being unsuitable for today's workforce (Skalka et al., 2019).

In Palestinian universities, the traditional instructional method is still preferred for learning, and it includes components such as teacher-centred instruction, which frequently concentrates on direct instruction using LCD projectors, PowerPoint slides to convey information in the classroom, observation, and assignment-based teaching. Students read

textbooks, memorise facts, complete, and take formal exams (Affouneh & Raba, 2017; Salhab, 2019). According to Velički and Velički (2015), the present generation has a shorter attention span for repetitive and boring static media (Velički & Velički, 2015). Using these static materials are ineffective in learning computer programming (Chen et al., 2019; Schmidt et al., 2015; Sobral, 2021). The delivery of knowledge is constricted by time, space, and the media at hand. The blackboard and figurative language are the primary methods of classroom instruction (Hassell et al., 2018). However, in order to engage students in the learning process, these static materials needed to be presented in an interactive manner using platform and online tools.

The development of critical thinking is a central objective of higher education. Palestine, like the rest of the Arabic region, continues to perform poorly in critical thinking (Al-mahrooqi & Denman, 2020; Alsarayreh et al., 2021; Qablan, 2019). As a result, the Palestinian Ministry of Higher Education (MOHE) intends to transform the education system from an instructional and memorisation strategy to a student-centred approach. Instead of spoon feeding students information, the teacher should become a facilitator who helps them build their skills and competences. The shift would overcome poor education quality and weak educational outputs (MOHE, 2017). Additionally, Palestinian vision 2030 proposed to reform educational system and developed strategies to improve students' higher-order thinking as a critical thinking skill and learning outcome (Ibrahim, 2020).

Computer programming courses are viewed as platforms for students to gain critical thinking skills (Mader, 2019; Muntean, 2019). Computer programming necessitates higher order thinking skills, such as problem analysis and presentation of

practical evaluation and solutions. However, Palestinian higher education does not adequately prepare students for critical thinking (MOHE, 2017). As a result, students enrolled in programming courses are unable to solve problems and incorporate solutions into algorithms. These problem-solving steps and algorithm development programmes help students think critically by solving, interpreting, and synthesising problems. A lack of critical thinking skills is linked to poor programming performance (Tayao, 2014).

Computer programming is regarded as critical in Palestine universities and is one of the primary requirements for many study plans (Demaidi et al., 2019). The concepts of programming are clarified theoretically, and limited practical work is performed. This negatively impacts student performance because students struggle to comprehend programming concepts (Demaidi et al., 2019). Palestinian programming students are plagued with a variety of problems when attempting to acquire programming skills, and the difficulties are i) inability to read and understand codes; ii) failure to synthesize newly acquired knowledge with previous knowledge; and iii) inability to understand or interpret abstract information (Alhazbi, 2016a; Alhazbi & Halabi, 2018; M. O. A. Hegazi & Alhawarat, 2015; Raj et al., 2018). Furthermore, students are discouraged from continuing their education because the programming content appears to be difficult. Alhazbi (2016), Askar and Davenport (2009), Han et al. (2010), Law et al. (2010), and Özden (2018) stated that the students' negative perception and low motivation to learn programming is due to their poor critical thinking skills, inability to make a connection between theoretical and practical education.

Many studies have found a relationship between critical thinking skills and academic achievement (Jacob, 2012; Ghanizadeh, 2017; León et al., 2015; Shirazi &

Heidari, 2019; Siburian et al., 2019; D'Alessio et al., 2019). To ensure that undergraduates are trained and equipped with the necessary skills, Palestinian education and training institutions should consider incorporating technology into their teaching and learning environments to assist their students in surviving when faced with conflicting learning (Fragkaki et al., 2015; Qaddumi et al., 2021; Salhab, 2019). Overcoming these issues from the beginning would have positive long terms effects on the country's business, and technology development as well-trained individuals would become experts who, in the future, would train and teach programming languages to the younger generation.

Academic achievement reflects success metrics demonstrating how well students have reached those aims and are the subject of practice in an education environment (Steinmayr et al., 2016). According to Qaddumi et al. (2021) and Hegazi and Alhawarat (2015), Palestinian's programming undergraduates face difficulties learning programming via conventional teaching and learning methods. The course contains abstract concepts and requires critical thinking to solve problems (Bawamohiddin & Razali, 2017; Gomes & Mendes, 2007), decomposing a problem into subtasks; reading and understanding code; and synthesizing this new knowledge with existing knowledge (Koulouri et al., 2015), all above result a high failure and low performance in computer programming (Krpan et al., 2015; Özden, 2018).

Motivation and interest in programming courses are two of the most common issues faced by programming students (Baser, 2013; Karaci, 2016; Shim et al., 2016; Tugun et al., 2017). Wang and Liou (2017) and McCord and Jeldes (2019) posited that students' motivational beliefs were positively correlated with computer programming achievement. Ryan & Deci (2000) explained students with low motivation levels would

not participate in learning activities and tend to be less successful than their motivated peers. Consequently, motivation could be employed as a reliable predictor of students' learning and academic achievement. Concurrently, what students learn might also affect their levels of motivation (Zusho et al., 2003). In addition, new strategies should be implemented to actively engage students in the learning process and increase their motivation.

Using Flipped classroom considered suitable model to learn computer programming, it supports the nature of the programming content which contains several skills as knowledge part and strategic part. using the video to learn the fundamental of programming language as syntax and semantics. Additionally, using the advantages of flipped classroom by free up the class time to focus on creating programming strategies, so the teacher can train students to think and solving problem to generate new programs. this help students to think critically in solving problems and enhance students' motivation through working in groups.

The flipped classroom is an innovative learning method that offers a more student-centered learning environment and more chances for active learning in the traditional classroom setting (R. Mccord et al., 2019). The phases of flipped classroom model, Pre-class and in-class can be employed to teach student the knowledge and semantics of programming language, this knowledge is the basis for other required programming skills like problem solving, building algorithm-based solutions, programming comprehension, debugging and fixing errors, and writing new programs, which can be targeted during class activities. Moreover, during class activities, students have the ability to interact more with the instructor, allowing them to receive more comments on their learning process,

which eventually increases their awareness of their weaknesses. Shortage in the research of flipped classroom in programming context (Taşpolat et al., 2021), and would flipped classroom help students to enhance critical thinking skills and motivated them to keep learning (C. Chang et al., 2020; Debbağ & Yıldız, 2021).

Previous research didn't provide effective steps of In-class activities design in programming flipped classroom (Ruiz de Miras et al., 2022), this study used novel structure PRIMM to design and plan the In-class activities and increase taking about programming.

PRIMM is a method to leaning programming that addresses the well-known issue of novices writing programmes before they can read them and integrates conversation and analysis of sample code via scaffolded activities (Sentance et al., 2019; Sentance & Waite, 2017). The PRIMM approach is a method teachers can use to structure a lesson with five components: Predict, Run, Investigate, Modify, and Make.

The purpose of this study is to design, develop, and evaluate the effectiveness of flipped classrooms in a computer programming course. Furthermore, to determine the effectiveness of flipped classrooms in improving students' academic performance, motivation, and critical thinking skills when learning computer programming. Finally, the study investigates undergraduate students' perceptions of the flipped learning strategy in the Palestinian context.

1.3 Problem Statement

The need to broaden computer programming education in higher education to support technological advancement and its role in driving innovation and economic growth in the 21st Century skill (Abesadze & Nozadze, 2020; Cheng & Shui-Ng, 2019). Also the important of equipping students with necessary skills such as critical thinking, the ability to work in a collaborative environment, access to information, and adaptability to new situations is imperative as they must cope with rapid technological development, to increase employers' high expectations, and a competitive work environment (Liesa-Orús et al., 2020).

Palestinians see technological advancement as an essential tool for their survival, as it would alleviate their daily challenges and overcome Israel's restrictions on movement and industry, promote emergency and equality in primary and higher education, improve the economy, and create more job opportunities (Qaddumi et al., 2021; K. Shraim, 2018). To ensure that ICT is implemented effectively in all areas, the next generation of young Palestinians, particularly those studying computer programming in universities, must be effectively trained to become good programmers.

Learning computer programming is not an easy task as the subject's content is challenging to master (Sobral, 2021), The course content's contains abstract concepts and requires an higher order thinking , as well as the need to acquire a different set of skills syntax knowledge, semantics knowledge and coding (S. I. Malik & Buraimi, 2021; S. I. Malik & Coldwell-neilson, 2016). Most students' challenges include losing motivation when faced with difficulty (Medeiros et al., 2018), as well as a lack of critical thinking

skills to deal with complex programming problems (Malik et al., 2019), all of which have an impact on student achievement and understanding.

Furthermore, Palestinian students are unable to think critically and solve problems (Al-mahrooqi & Denman, 2020; Alsarayreh et al., 2021; Qablan, 2019), which contributes to them failing to meet course requirements and increasing the number of dropouts and failure among Palestinian programming undergraduate students (Demaidi et al., 2019). As a result, they are prone to losing their interest in learning when they face difficulties when attempting to understand programming concepts and manage problems and would eventually lose their interest to learn (Paiva et al., 2020; Michailidis et al., 2019). MOHE (2017) stated that 21% of students prefer science including computer programming while 76% prefer literary disciplines. This inequality creates a huge labor market's need for skilled technicians and professionals.

The second consideration was introduced by Alammary (2019) who stated that lacking effective strategies in learning leads to poor programming skills among students in higher education. While Sobral (2021) stated that the computer programming teaching process is based on a teacher-centred approach that causes student boredom. The final and most important consideration is that the current Palestinian curriculum falls short of improving critical thinking skills through memorisation MOHE (2017). Furthermore, the students reached the degree of 42.9% in thinking skills, which is below the global proficiency levels 80%. However, Kanika and Chakraborty (2020) and Moreira et al. (2021) introduced a positive claim that innovation and effective learning strategies play a significant role in improving the student's understanding of programming. (Cheah, 2020)

also believed that programming could be taught using various methods to help students acquire the skill better.

Another significant factor is academic achievement. According to D'Alessio et al. (2019) and Shirazi & Heidari (2019), students with good critical thinking skills positively influence students' academic performance. Both studies emphasized the importance of incorporating critical thinking activities in the lessons, particularly for those at the tertiary level. The suggestion that critical thinking skills be incorporated into lesson planning. They believe that teachers or course instructors should seriously consider teaching their students using methods that help them improve their critical thinking skills.

To address issues faced by computer programming students, it is time to identify learning strategies that would help students learn the course (Pattanaphanchai, 2019). Due to the fact that the majority of programming courses are taught conventionally (teacher-centred), Durak and Güyer (2016) asserted that the conventional teaching method emphasises theory over practical knowledge. As a result, students are deprived of opportunities to practise their programming skills because they are only given a scheduled time to do so. One reason for failure among programming students is the limited opportunity to practise programming first hand (Skalka et al., 2019, Alammary, 2019). More research is required to find a practical student-centred teaching approach that emphasises increased practise and prompting critical thinking skills in computer programming undergraduates.

Having recognised the contributors to loss in the learning of computer programming that continue to the present day, the researcher is inspired to perform this

study in order to examine and uncover more effective ways to assist students in learning computer programming. Moreover, considering the benefits of the Flipped Classroom model (Bergmann & Sams, 2012b): that it makes classes more student-centred (O'Flaherty & Phillips, 2015), that it makes classroom time more productive (Elmaleh & Shankararaman, 2017), and that it provides students with the opportunity to learn independently. It raises the question of whether this method would be advantageous for teaching computer programming.

Studies on the effect of the flipped classroom on learning computer programming are still limited (Halabi et al., 2019). Using new methods in learning may be met with resistance; some previous research has a positive perception, while others have a negative effect. The culture factor is considered an important factor in determining the student's perception of new strategies such as the flipped classroom; however, few studies have been conducted in Arabic culture (Alhazbi & Halabi, 2018). The current study seeks to re-examine student perceptions in the Palestinian context. The requirement to use quantitative methodology to assess student perception of the flipped classroom (Cilliers & Pylman, 2020; Fuchs, 2021).

Previous studies have demonstrated that academic achievement is positively correlated with student motivation in traditional and online learning environments. However, it is unknown whether the same motivational patterns exist in flipped classrooms as they do in traditional or online learning environments (Xiu & Thompson, 2020). It has been noted that the correlation between critical thinking and academic achievement may provide conflicting results, number of research have found favourable associations (Afshar et al., 2014; Akpur, 2020; D'Alessio et al., 2019; Fong et al., 2017;

Ghanizadeh, 2017; Siburian et al., 2019), others have found no significant association (Doleck et al., 2017; Kanbay et al., 2017; Mohammadi et al., 2016; Shirazi & Heidarsi, 2019; Tafazzoli et al., 2015). The inconsistent relationship between critical thinking skills and student achievement prompted the researcher to examine this relationship in the Palestinian context utilising the flipped classroom model.

Despite the effectiveness of flipped learning, there is a scarcity of research on the teaching and learning approach in the context of computer programming (Hirata & Hirata, 2020; Maheshwari et al., 2020). Moreover, no previous studies in a Palestinian context. The reviewed literature showed that most studies involving programming students investigated the roles of self-efficacy and achievement in a flipped learning environment. More research is needed to answer the question of whether the flipped classroom, which is proposed as a strategy in this study, would help develop computer programming undergraduates' critical thinking skills and keep them motivated when faced with programming challenges. These variables are also important in assisting students in achieving higher grades in their computer programming courses.

The purpose of this study is to examine the critical thinking skills, motivation, and achievement of computer programming undergraduates when taught programming language using a flipped classroom approach. In addition, it examines the inconsistent correlation between each of critical thinking skills and student motivation on student achievement to determine the relationship between the two in a flipped classroom in a Palestinian context.

This investigation identifies the learning challenges faced by computer majors so that course instructors can provide a positive learning environment, meet students' academic needs, and reduce dropout rates, especially for those students who are new to the course. Furthermore, it is essential that university courses be taught and learned in flipped classrooms because the flipped learning model is not well understood or implemented in the Palestinian education system.

This study employs Information and Communication Technology (ICT) in a flipped learning model by creating instructional videos for programming knowledge (including syntax and semantics) and for analysis and programme creation. In addition to PRIMM activities supported by online discussion and assessment to encourage student participation and promote critical thinking skills and motivation.

1.4 Research Objectives

The following objectives guided the design of the study:

1. To design and develop instructional material using flipped classroom environment for learning computer programming course among Palestinian university students.
2. To investigate the effects of flipped classroom implementation in the critical thinking skills pre-test and post-test of undergraduate students in learning computer programming.
3. To examine whether there is any significant difference in critical thinking skills post-test of undergraduate students in learning computer programming between experimental group and control group.

4. To investigate the effects of flipped classroom implementation in the motivation pre-test and post-test of undergraduate students in learning computer programming.
5. To examine whether there is any significant difference in motivation post-test of undergraduate students in learning computer programming between experimental group and control group.
6. To investigate the effects of flipped classroom implementation in the academic achievement pre-test and post-test of undergraduate students in learning computer programming based on skills type.
7. To examine whether there is any significant difference in academic achievement post-test of undergraduate students in learning computer programming between experimental group and control group based on skills type.
8. To identify the correlation between students' critical thinking skills and students' achievement when learning computer programming using flipped classroom environment.
9. To identify the correlation between students' motivation and students' achievement when learning computer programming using flipped classroom environment.
10. To identify the correlation between students' critical thinking skills and students' motivation when learning computer programming using flipped classroom environment.

11. To explore students' perceptions on the effectiveness of the flipped classroom environment.

1.5 Research Questions

The research questions examine the effects of the flipped learning model in computer programming education on the motivation, achievement, and critical thinking abilities of Palestinian university students in comparison to non-flipped instruction. The specific questions in this case are as follows:

1. How was the design and development of instructional material using flipped classroom environment for learning computer programming course among Palestinian university students?
2. What are the effects of flipped classroom implementation in the critical thinking skills pre-test and post-test of undergraduate students in learning computer programming?
3. Is there any significant difference in critical thinking skills post-test of undergraduate students in learning computer programming between experimental group and control group?
4. What are the effects of flipped classroom implementation in motivation pre-test and post-test of undergraduate students in learning computer programming?
5. Is there any significant difference in the motivation post-test of undergraduate students in learning computer programming between experimental group and control group?

6. What are the effects of flipped classroom implementation in the academic achievement pre-test and post-test of undergraduate students in learning computer programming based on skill type?
7. Is there any significant difference in academic achievement post-test of undergraduate students in learning computer programming between experimental group and control group based on skill type?
8. Is there any significant relationship between the students' critical thinking skills on learning computer programming and their achievement on learning computer programming using flipped classroom environment?
9. Is there any significant relationship between the students' motivation on learning computer programming and their achievement on learning computer programming using flipped classroom environment?
10. Is there any significant relationship between the students' motivation on learning computer programming and their critical thinking skills on learning computer programming using flipped classroom environment?
11. How do students perceive the effectiveness of the flipped classroom environment?

1.6 Research Hypotheses

The purpose of this study is to decide whether to accept or reject the following null hypotheses. The hypotheses are determined by the level of the probability value. The Alpha significance level is set at 0.05 and is used to test statistical significance.

$H_0$1. There is no significant of flipped classroom implementation in the critical thinking skills pre-test and post-test of undergraduate students in learning computer programming.

$H_0$2. There is no significant difference in critical thinking skills post-test of undergraduate students in learning computer programming between experimental group and control group.

$H_0$3. There is no significant of flipped classroom implementation in motivation pre-test and post-test of undergraduate students in learning computer programming.

$H_0$4. There is no significant difference in motivation post-test of undergraduate students in learning computer programming between experimental group and control group.

$H_0$5. There is no significant of flipped classroom implementation in the academic achievement pre-test and post-test of undergraduate students in learning computer programming based on skill type.

$H_0$6. There is no significant difference in academic achievement post-test of undergraduate students in learning computer programming between experimental group and control group based on skill type.

$H_0$7. There is no significant correlation between students' critical thinking skills on learning computer programming and their achievement on learning computer programming using flipped classroom environment.

$H_0$8. There is no significant correlation between students' motivation on learning computer programming and their achievement on learning computer programming using flipped classroom environment.

$H_0$9. There is no significant correlation between students' motivation on learning computer programming and their critical thinking skills on learning computer programming using flipped classroom environment.

$H_0$10. The computer programming students' have a negative perception on the effectiveness of the flipped classroom environment.

1.7 Significance of the Research

This study aims to bridge the gap in flipped classroom effectiveness by comparing the former against the non-flipped learning approach. Furthermore, the study also looks at students' critical thinking skills and academic achievement in the computer programming language and motivation.

The design of in class activities in flipped classroom are not provided in effective steps (H. Özyurt & Özyurt, 2018), this study used the novel structure PRIMM to plane the in-class activates and increase talking about programming (Sentance et al., 2019). This integration between PRIMM approach and flipped classroom is still needed.

Arabic country is in the infancy of flipped classroom innovation (Etemadfar et al., 2020). This topic is of great interest to the researcher, as no studies have examined the effect of critical thinking skill in programming flipped classrooms. In addition, motivational patterns associated with students' learning performance in flipped classrooms (Xiu & Thompson, 2020). The inconsistent relationship between critical thinking skills and academic achievement requires further research. Moreover, there is

still a need to examine programming achievement based on skilled type (Alhazbi & Halabi, 2018).

Qualitative studies to evaluate student perception toward the flipped classroom are still required (Fuchs, 2021). Additionally, the culture factor is considered a significant factor in determining students' perceptions of new strategies such as the flipped classroom, despite the paucity of research on Arabic culture (Halabi et al., 2019).

As a result, the current study aims to contribute to the flipped learning literature. To answer the research questions, this study adopts Piaget's cognitive, self-determination, and Vygotsky's Zone of Proximal Development (ZPD).

1.7.1 Theoretical Significance

The theories used to support this study, as well as the primary findings, assist future researchers and programming educators in understanding how programming is taught and how students' thinking skills, motivation to learn, and academic performance are affected. The study's contribution to programming would be significant because other course instructors could use the findings to adopt and adapt a flipped learning approach in their classrooms. As a result, this research could lay the groundwork for a better understanding of the relationship between learning computer programming through flipped learning and undergraduate students' critical thinking skills, motivation, and academic achievement.

1.7.2 Practical Significance

This study benefits two key stakeholders, namely Palestine Technical University Kadoorie (PTU-K) principals, lecturers, and Palestinian education policymakers.

Furthermore, the findings are hoped to provide lecturers with a set of knowledge areas that was assist them in developing their students' overall performance. The proposed framework guides lecturers when planning lessons to encourage students to learn and use computer programming while also developing their critical thinking skills.

According to the literature, computer programming difficulties necessitated new learning strategies (Demaidi et al., 2019), and little attention has been paid to flipped learning in the Palestinian context (Khaled et al., 2019). This would be the first study in university and Palestine to investigate and apply the flipped learning model in computer programming education.

The findings are hoped to accelerate and simplify the integration of innovative pedagogical approaches in the teaching and learning process, which continues to be a significant challenge for the Palestinian Ministry of Education and Higher Education (MOHE, 2017). This research would be extremely beneficial to policymakers in planning future academic strategies to improve the teaching and learning process. In addition, it may assist curriculum designers in enhancing computer programming textbooks and instructional strategies.

This study is in response to the Palestinian Teacher Education Strategy, which calls for the use of innovative and promising methods, such as instructional video recordings of various teaching practises, educational technology, and interactive case-based learning (Qaddumi et al., 2021). Moreover, the research results would add value to the teaching/learning process when the suitable resources are utilised with intent (MOHE, 2017).

After 16 years in the education industry, the researcher believes that this study emphasises the importance of implementing a modern learning strategy that is focused on the needs of students. The findings are hoped to be used as guidelines by other educators and policymakers when attempting to implement or integrate the flipped learning concept in higher education in order to provide students with critical 21CS and knowledge. Furthermore, the researcher discovered no study that has solely investigated ICT integration or the flipped learning model in undergraduate computer programming education in Palestine.

1.8 Research Limitations

Limitations occur in every research, limits that the researcher cannot control; the limitations in this study are primarily the four issues listed below. The first limitation is the time required to collect data from participants, as the study lasted eight weeks. The time allotted for data collection may be insufficient because completing a C++ programming course takes more time. The second limitation is that the sample size in this study is limited to undergraduate students at a local university in Palestine. As a result of the differences in cultures, social, and economic backgrounds, the findings may not be applicable to other studies. This study's subject is limited to an introduction to C++ programming. As a result, it limits the findings' generalisation to other subjects' curriculum.

Furthermore, the purposive sampling method would be used, with participants assignment randomly from the current enrolment in the programming introductory course. Finally, there are numerous ways to implement learning materials in a flipped classroom