

Integrating Problem-Based Learning Into Blended Learning To Enhance Students' Programming Skills

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Abstract—The aim of this research is to enhance students' programming skills by incorporating problem-based learning into blended learning. In the quantitative dimension of the study, a pre-test and post-test quasi-experimental design with a control group was used. The study groups included 100 university students. In the experimental group, the blended learning method was used which combines face-to-face learning with the syntax of problem-based learning and online learning. During live online classes, the Teams platform was used. The traditional lecture methods were used in the control group without any intervention. As a data collection tool, the Learning Achievement Test was used. The findings revealed that there was effect of treatment on student achievement. This strategy also directs and frees classroom time.

Keywords— blended learning; platforms; online learning tool; problem-based learning; programming course.

1 Introduction

Programming is one of the top ten most wanted jobs in 2021. It is also estimated that will be a global shortage of software engineers [1].

The skills gap is the difference between what the employer expects

of the employee and what the employee gives or does. This programming skills gap demonstrates that many Egyptian workers fail to meet expectations. This wide gap came as a result of workers' lack of knowledge and training.

Fundamentals of programming skills are also required for college students in order to complete class assignments. When it comes to learning programming skills, students frequently struggle. Students were struggled when asked to work on more complex tasks. This difficulty becomes more apparent when the learning process in the computer lab is carried out by an inexperienced instructor, resulting in a situation in which they must repeatedly repeat the explanation and steps. Finally, the instructor does not have enough time to deliver all of the learning materials. These circumstances also contributed to an unsatisfactory learning outcome.

Also the difficulty of understanding the basic of programming influences the high dropout rate in Computer Science courses.

Thus, Enhancing students' programming skills has become critical [2]. Student needs to understand the concept, which will lead to more ideas and, as a result, problem-solving will become easier. To begin learning about programming, one must first understand the fundamentals of programming. Learners must understand that in order to communicate with computers, they must first learn the language that computers understand [1].

In learning computer programming, researchers must develop strategies to address this issue [3]. Despite that multiple strategies are being used at all levels to attract students to the field; there is still a shortage of programmers. Furthermore, difficult situations such as emergencies and crises make teaching and learning extremely difficult. During such difficult times, there is a typical shift from face-to-face to online and blended deliveries. While all disciplines are affected, programming is the most severely affected.

In order to teach programming, a variety of teaching methods and techniques are used. Live coding, in which instructors write code in front of students, assisting them in understanding the code while also answering any questions the students may have at the time. This technique relieves the pressure on the students' minds, allowing them to focus on the other new concepts[4].

1.1 Integrating problem-based learning into blended learning review

Several studies have been published that demonstrate the benefits and motivation created in students by using active methodologies as

opposed to passive learning in large classes, where students are encouraged to learn to programme by thinking about what they are doing [5]. In addition, a conceptual framework of problem-based learning (PBL) is proposed with the goal of improving students' problem-solving and programming skills [6].

In natural science and social science, the Problem-Based Learning (PBL) approach has been studied [7, 8]. The study covers investigations on different PBL variables, such as self-regulated and achievement in programming.

PBL begins with a problem to be solved in such a way that students must first acquire new knowledge before they can solve it. Students interpret, gather new information, identify potential solutions and methods, develop problem-solving skills, collaborate, analyse, and evaluate problem-solving to reach their conclusion. PBL is a pedagogy that centres student learning on open-ended, student-driven problems facilitated by a lecturer to achieve the learning outcomes of a course [9].

PBL has been thoroughly researched and documented as an effective strategy for improving students' learning outcomes in programming classes [10, 11] [12].

However, as far as the researcher is aware, its effectiveness with blended learning to improve programming student skills in Egyptian university has yet to be confirmed. Furthermore, the efficacy of PBL in the educational classroom has yielded mixed results. Take, for instance, [13] concluded that problem-based instructional approaches were less effective than blended learning in terms of student achievement. It was also suggested that efforts be made to incorporate the philosophy of blended learning and PBL into the curriculum. But also positive impacts have been reported on problem-based learning. (PBL) has been explored as a method in a Computer Course for Pre-service Teachers which revealed that the PBL group achieved significantly higher levels of achievement [14].

Both e-learning and face-to-face learning were effective in improving students' performance, and a blended learning method that combines the two is better than each of them [15]. Blended Learning is an educational method that combines online learning activities with traditional classroom methods [16]. Implementations of blended learning have resulted in better student learning outcomes in many or several experiments [17, 18] and [19].

The benefit of blended learning is that it allows for more interaction between students and lecturers through online discussions [20]. Blended learning, can increase access and improve interaction because students can access learning materials and participate in online discussions at any time and from any location [21].

On the other hand, blended learning allows for more interaction between students, lecturers, and learning materials in the classroom. Lecturers can walk around the classroom and assist students who are having difficulty completing their assignments. For out-of-class activities, students engage in online learning via videos and other predetermined sources. Research conducted by [22] showed that most students who carry out blended learning have a positive attitude towards the blended learning model. Research by [16] showed that the combination of online and face-to-face learning results in a more interactive lecture approach.

Online learning outside of the classroom can make students anxious because there is no physical presence of lecturers, and students may question whether they are learning correctly. Students must be motivated to complete their assignments, in blended learning

[23]. So, learning must be carefully designed to motivate students.

With problem-based learning into blended Learning, scheduled activities in the Teams platform can increase student motivation through interaction and participation [24]. Students prepare themselves before entering the classroom by studying the materials in the form of videos, audio, or other digital files, which can be accessed at any time and from any location outside of class. These learning materials can be delivered online. Discussions in activities can be conducted via the Teams. The lecturer assigns tasks and problems to students for in-class activities.

Problem-based learning into blended Learning also combines the advantages of active learning in the classroom as a result of (PBL) and active learning outside the classroom (Teams) as a result of blended learning [25]. Furthermore, active learning also happened due to the problem-based learning.

Active learning is a learning strategy in which students actively participate in the learning process by engaging in a variety of activities [26]. Active learning can be developed through assignments in and out of the classroom that require students to work on or

produce something, give projects that are completed in groups, or involve students in assisting their friends who are having difficulty learning.

Active learning can happen during classroom meetings or platform discussions [27]. Building a learning community, using an online tool for interaction (Teams), and providing time to respond and input are some strategies for developing active learning in an online learning environment.

Online learning may encourage active learning because learners often take the initiative to search for information on the internet to complete their tasks [28]. And discuss ideas with other students or lecturers on the internet. (PBL) into blended Learning may successful in improving student learning outcomes because it aids in the reduction of cognitive load [23].

The nation needs computer programmers whereas the students are dropping out complaining about the difficulty of the subject. The research will help students, course facilitators, and researchers know how integrating problem-based learning into blended learning teach difficult subjects such as computer programming.

1.2 Research questions

The goal of this study was to look into the effects of incorporating problem-based learning (PBL) into blended learning to enhance students' basic programming skills in programming courses. Students have contact with new subjects before the classroom, using videos, texts, or other material on the Teams platform, as well as small tests to check their knowledge. As a result, face-to-face classes are reserved for problem-solving (PBL).

The purpose of this study is to integrate PBL into blended learning and investigate the integration to enhance students' basic programming skills. The present study attempted to answer the question raised about the effect of integrating PBL into blended learning for college students.

The study addressed the following research question:

RQ1. What is the main effect of PBL into Blended Learning, traditional lecture methods (TLM) on enhancing students' basic programming skills?

The hypothesis for this quantitative study is as follows:

H: Students taking part in the problem-based learning into blended learning with the Teams platform will show positive growth in their performances compared to

students that did not participate in the treatment.

2 Method

The study was pre-test and post-test quasi-experimental design used in the quantitative dimension of the study, in this study, used in the Programming Course in University. The fundamentals of programming are introductory courses required of computer science students. This

course is offered during the first semester.

2.1 Design of the research

The stages that were carried out in implementing PBL into blended learning with the Teams Platform used to enhance students' basic programming skills consist of four stages. Those stages can be seen completely in Figure 1.

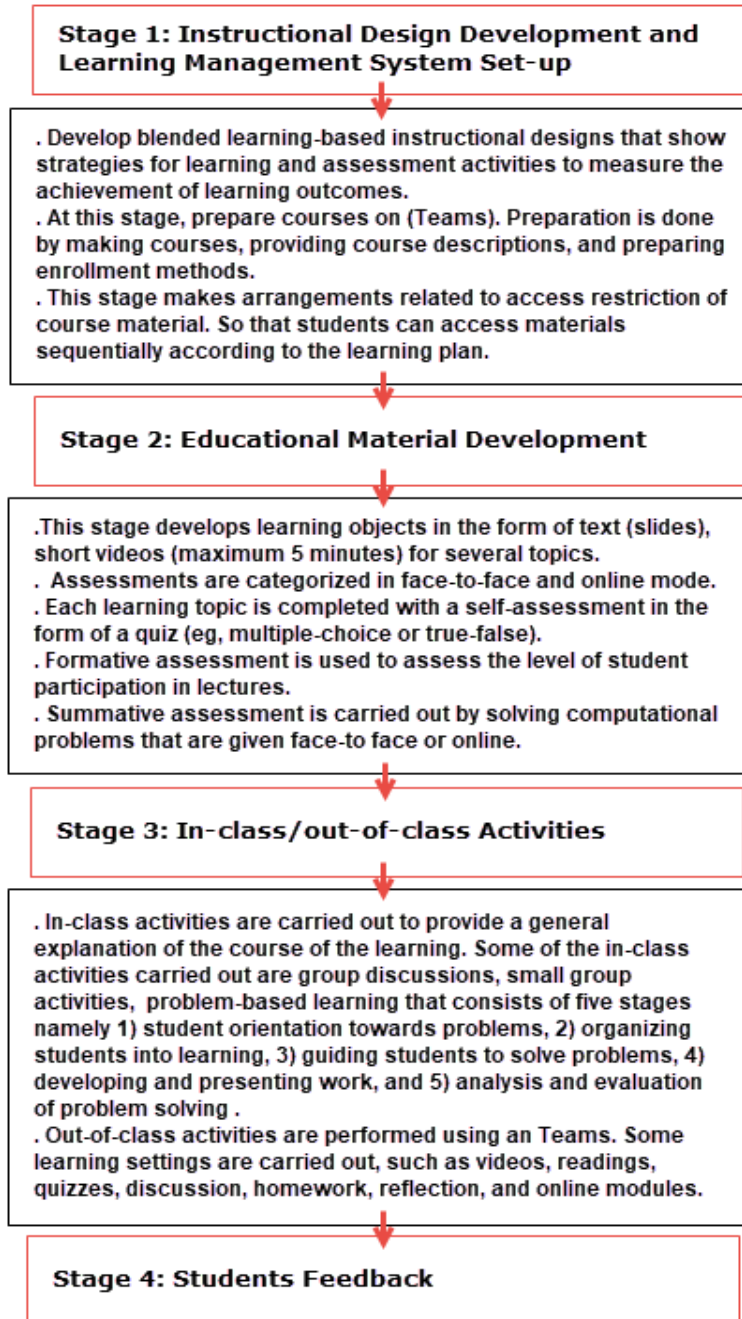


Fig. 1. Stages of integrating PBL into blended learning.

2.2 Sample/ Participants

The research population consisted of 100 first-semester students in the Computer science program. Learning is carried out using the problem-based learning in the Blended

Learning with the Teams platform. All participants were informed in advance regarding the use of collected data for research purposes. The design of the research experiment is listed in Table 1.

Table1. The research design in symbolically illustrated

Pretest	Treatment	Posttest
O1	PBL into Blended Learning	O2
O1	TLM	O2

Information:

O1: Pretest to measure Learning Achievement before application of treatment

O2: Posttest to measure Learning Achievement after application of treatment

2.3 Instrument(s)

The instrument was developed and used in the study for data collection. The Programming

Achievement Test (PAT) is a multiple-choice objective test. It consists of forty (40) multiple-choice objective test items. Each test item is followed by four answer choices (A—D), from which the student is expected to choose the correct alternative. The test content for the study was covered in the levels of cognitive domain of Remembering (knowledge), Understanding (comprehension & application), and Thinking in the test contents (analysis, synthesis, & evaluation).

Table2. Achievement Test Item

Content	Cognitive Levels			Total
	Remembering	Understanding	Thinking	
conditional commands	4	4	4	12
Loops	3	4	4	11
Variables	2	3	3	8
Functions	3	3	3	9

Total	12	14	14	40
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The reliability coefficient was calculated using the Kuder-Richardson formula 21 with a sample group of 40 non-study group students. PAT's reliability value was calculated to be 0.82.

2.4 Data collection procedures

The research covered eight weeks. Students in the experimental and control groups were pretested on the PAT before the start of instruction. The purpose of the pre-treatment was to determine the students' prior knowledge in both the experimental and control groups before beginning the experiment.

In the control group, the researcher used the traditional lecture method to teach the students, adhering to an already prepared instructional plan within the context of the study's contents. In short, the control group's teaching was largely dominated by the teacher, and learning was confined to the classroom.

In the area of presentation, the instructional lesson plan implemented in the control group differed from that implemented in the experimental group. In the control group, the presentation followed

the routine traditional activities. The researcher in the control group organized the entire class as a unit, making notes on the chalkboard about concept definitions, with researcher-directed questions; students discussed the concepts and examples. In the control group, students received instruction and participated in discussions based on the researcher's explanations and questions for the majority of the instructional time. In short, the control group's teaching was largely researcher-dominated, and learning was confined to the classroom. The control group received classroom instruction twice a week for 60 minutes each.

Before beginning the actual implementation of PBL into Blended Learning in the experimental group, the researcher arranged the seating in a semi-circular form that allowed the researcher to walk across the groups and the participants to face the chalkboard. A week was divided into two periods of 60 minutes each, just like the control group. In the PBL into Blended Learning group, the PBL process adopted consisted of five phases[27] namely: (i) student orientation towards problems, (ii) organizing students into learning,

(iii) guiding students to solve problems, (iv) developing and presenting work, and (v) analysis and evaluation of problem-solving. In each of the topics taught, students in the PBL into Blended Learning were

assigned tasks that required them to surf the Teams platform and preparation for the lecture that display the Live coding method, as shown in Figure 2.

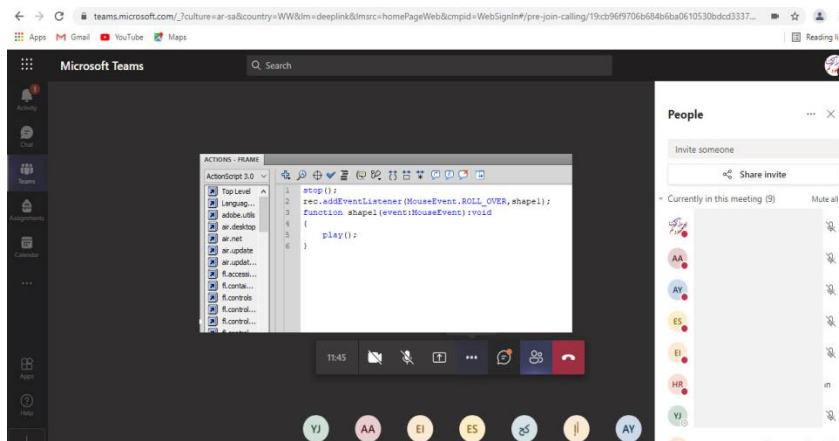


Fig. 2. Teams application used in PBL into blended learning.

The teaching to groups was completed in the seventh week, and the eighth week was used for the administration of the PAT as a post-test. It should be noted that a re-

organized version of the pretest was used as the posttest to avoid familiarisation with the pretest. Table 3 provided a summary of the field-work activities over eight weeks.

Table3. Field work Activities

Week	Activities
1 st	Selection and training of research assistants on the administration of instruments, selection of groups, categorization of groups into experimental group and control group, random selection of intact groups, Sensitization of participating students.
2 nd	Administration of PAT as pre-test on both the experimental and control groups

Week	Activities
3rd, 4th, 5th,6th, 7th	Implementation of training packages in experimental and control groups i.e. teaching in the experimental group by integrating PBL into Blended Learning , and control group using TLM.
8 th	Administration of PAT as post-test on both the experimental and control groups.

2.5 Data analysis

The descriptive statistical tool of means and standard deviations was used to analyse the quantitative data collected using PAT. This study looked at how participants performed in programming courses before and after treatment in both

the experimental and control groups.

3 Result

Research Question: What is the main effect of PBL into Blended Learning, traditional lecture methods (TLM) on enhancing students' basic programming skills?

Table4. Result of statistical analysis of pre-test students' achievement

Treatment	Pre-test		N	Df	t	Sig
	Mean	SD				
PBL into Blended Learning	10.74	1.15	50	98	0.084	0.67
TLM	10.72	1.21	50			

The value of t in the previous table is not statistically significant, which indicates that there is no statistically significant difference between the average scores of the two

groups in the pretest, which confirms the existence of parity between two groups in the knowledge of the programming course.

Table5. Result of statistical analysis of post-test students' achievement

Treatment	Pre-test		N	Df	T	Sig
	Mean	SD				
PBL into Blended Learning	36.02	1.15	50	94.19	22.35	0.016
TLM	26.20	1.21	50			

Results showed in Table 5 above that there was a statistically significant at the significance level of 0.05, returns to main effect of treatment on students' achievement. the mean of the post-test scores for the PBL into Blended Learning group (Mean = 36.02, SD=1.15) was higher than the mean of the Traditional Lecture Method (TLM) group (Mean =26.20, SD=1.21).These results connote that the students in the PBL into Blended Learning group recorded high difference in programming courses achievement than their counterparts in the TLM group. This is in line with the submission that the learner-centred instructional strategies might improve the achievement of students[29] and in the present study achievement in programming courses [30]

4 Discussion

Initially, emphasis was placed on the selection of groups with comparable characteristics in terms of

age, language, and so on. This was done to ensure that any observable significant difference in the mean post-test scores of the two groups on the PAT was attributed to the intervention rather than chance. This set the stage for the discussion of findings in relation to the above-mentioned research question one and hypothesis, which were examined in the preceding section of the current study.

During interviews, it was discovered: (1) According to students, the training provided is sufficient for them to gain the necessary skills; (2) The lecture with live coding method in Teams is clear; and (3) Students encountered difficulties while working on assignments in class, but these difficulties were overcome because they could receive direct assistance from the lecturer. Furthermore, students did not feel discouraged because the presence of the lecturer aided them.

There was a significant main effect of treatment on students' skills in programming courses, according

to the findings. When compared to the traditional lecture method, the results revealed that when students were exposed to the teaching strategy of Integrating PBL into Blended Learning, their preferred difficult tasks more than easy tasks because it motivated them to learn more. This discovery supported previous findings [16, 23], which linked improved performance learning to learner-centered teaching methods. This was further supported by the fact that learner-centered teaching strategies helped to clear up misconceptions about the nature of programming [31].

In this study, integrating PBL into blended learning had a positive impact on students' acquisition of programming skill when compared to the traditional teaching method. This indicated that the learning materials developed with Teams platform were effective in improving student performance.

The results showed that there was students' skills improvement in the control group, but it was not the same as in the experiment group. The results also showed that the average of post-tests in the experiment group was higher than in the control group. The traditional teaching method had only been lambasted for prioritizing teacher activity over student involvement

[13], that it harmed students' learning.

In this study, integrating PBL into Blended Learning was found to be effective in promoting programming skill because the strategy allowed learners to blend their experiences in face-to-face teaching with Teams platform learning. The online experience appeared to have solidified students' understanding of programming. The discovery that students exposed to PBL into Blended Learning performed better in programming supported the views of both PBL and Blended Learning proponents that the strategy was effective in improving students' programming skills.

Integrating PBL into Blended Learning was found to be effective in promoting skill in programming, because the strategy enabled learners to blend their experiences in face-to-face teaching with online learning. The discovery that students exposed to the strategy performed better in programming supported the views of PBL into Blended Learning proponents that the strategy was effective in improving students' skills [32]. In [33] found that PBL into Blended Learning students, among others, achieved better. Similarly, in [34] found that PBL into Blended

Learning students valued the student-centred nature of PBL, including information seeking, group work, and the material's personal relevance.

5 Conclusions

This study has shown the effectiveness of the integrating PBL into blended learning in promoting students' achievement in programming. It is therefore recommended that this strategy be put to use in the teaching and learning of programming courses.

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