Introducing Problem-Based Learning to Blended Learning in Order to Improve Students' Programming Skills

Doaa M. Hawa[1]*, Eman Ghoniem[2], Abeer M. Saad[1]

[1]*Computer Teacher Preparation Dept, Faculty Of Specific Education, Damietta University, Egypt,
Email: d_amin@du.edu.eg
[2]Educational Technology, Dept, Faculty of Specific Education, Zagazig University, Egypt,
 Email: emangamal@zu.edu.eg
[1]Computer Teacher Preparation Dept, Faculty Of Specific Education, Damietta University, Egypt,
 Email: asaad@du.edu.eg

Corresponding Author: DOAA M. HAWA
*Computer Teacher Preparation Dept, Faculty Of Specific Education, Damietta University, Egypt,
Email: d_amin@du.edu.eg

Abstract
Through the use of problem-based learning and blended learning, the purpose of this study is to improve students' programming abilities. For the quantitative portion of the investigation, a pre-test and post-test quasi-experimental design with a control group were used. One hundred college students participated in each of the study groups. Blended learning is a technique that blends traditional classroom instruction with the syntax of problem-based learning as well as internet learning. This approach was used in the experimental group. Teams platform was used during the live online class sessions. The standard lecture approaches were used as usual in the group that did not receive any intervention. The Learning Achievement Test was used here as a device for the collecting of data. According to the data, there was an impact therapy on the accomplishments of the students. This technique not only organizes but also frees up time in the classroom.

Keywords: blended learning; platforms; online learning tool;

Introduction

In 2021, programming will be one of the top 10 occupations that employers are seeking to fill. In addition to this, it is anticipated that there will be a scarcity of software developers around the world [1]. A skills gap exists when there is a disparity between what an employer expects of an employee and what the person provides or performs. Their lack of programming abilities shows the fact that many Egyptian employees are unable to satisfy expectations. Due to a lack of education and training on the part of the workforce, this significant gap emerged.

For college students to successfully finish their assigned coursework, they need to have a fundamental understanding of programming. Students commonly have difficulty while attempting to master skills related to programming. When asked to complete increasingly tricky activities, the students had trouble doing so. This challenge becomes much more obvious when the learning process in the computer lab is carried out by an incompetent instructor, which results in a scenario in which the learner is forced to repeat the explanation and the actions continually. Last but not least, the teacher does not have sufficient time to provide all of the available educational resources. These conditions also had a role in producing undesirable results for the learning process. The difficulty of learning even the most fundamental concepts of computer programming is another factor that contributes to the high dropout rate in computer science classes.

Consequently, it is now more important than ever to improve students' programming abilities [2]. The student has to understand the topic since this will result in additional ideas, which will make it simpler to find solutions to problems. To start learning how to program, one must first get familiar with the foundations of programming. Learners have a responsibility to realize that to interact with computers, and they must first acquire a language that can be understood by computers [3]. Researchers must create techniques to solve this difficulty in order to learn computer programming [4]. There is still a scarcity of programmers even though a variety of approaches are being employed on all levels to encourage students to pursue careers in the industry. In addition, challenging circumstances, such as unexpected events and critical situations, make it incredibly challenging to teach and learn. When things are as bad as they are right now, there is often a trend away from in-person interactions toward online and mixed delivery methods. Programming is the field that is most badly affected, despite the fact that other fields are being impacted. A wide range of instructional strategies and approaches are used in the process of instructing students in programming. Live coding is a kind of instruction in which teachers write code in front of students, guiding them through the process of comprehending the code while also responding to any questions the students may have at the moment. This method reduces the mental strain that the pupils are under, which enables them to concentrate more clearly on the other novel ideas [5].

1.1 Integrating problem-based learning into blended learning review

In order to solve this problem, scholars studying computer programming need to design certain solutions [6]. Even though many different tactics are being utilized on all levels to encourage students to pursue careers in programming, there is still a scarcity of programmers. Teaching and learning are much more challenging when confronted with trying circumstances[7,8] such as catastrophes and disasters. In difficult circumstances like these, there is often a trend away from in-person delivery methods toward online and mixed methods. While all areas of study are being impacted, computer programming is being hit the worst.

PBL stands for problem-based learning, and it is a methodology that centres student learning on open-ended problems created by students themselves and assisted by a lecturer to meet the learning goals of a course [9]. PBL, or problem-based learning, has been the subject of many studies and is an effective technique for enhancing the learning outcomes of students enrolled in programming programs [10, 11] [12]. Despite this, the researcher has not been able to ascertain whether blended learning enhances programming student abilities in Egyptian universities. In addition, there has been a lack of consensus on the effectiveness of PBL in the context of the educational classroom. For example, the conclusion reached in [13] stated that problem-based teaching techniques were less successful than integrated learning in terms of their impact on student accomplishment. Additionally, it was recommended that attempts be made to include the principles of project-based learning and blended learning in the instructional design of the program. However, there have also been reports of good effects brought about by problem-based learning. (PBL) has been investigated as a possible strategy for use in a Computer Course designed for Pre-service Teachers. The results of this investigation revealed that the group that participated in (PBL) attained considerably greater levels of accomplishment [14]. E-learning and traditional classroom instruction both helped students improve their performance; however, blended learning, which integrates the two types of instruction, was shown to be superior to either of the individual approaches [15]. The term "blended learning" refers to a teaching approach that mixes conventional in-class instruction with educational activities that take place online [16]. In many or a few trials [17, 18], and [19], the implementation of blended learning led to improved student learning results [17, 18] and [19].

One advantage of blended learning is that it allows students and instructors to engage in greater conversation via online forums [20]. Blended learning allows students to access learning materials and engage in online conversations whenever and from anywhere they want [21]. This allows blended learning to enhance access and improve interaction among students. On the other side, blended learning makes it possible for students, teachers, and course materials to engage in greater conversation within the classroom setting. Students who are having problems completing their tasks may get assistance from the lecturers as they circulate around the classroom. In addition, students participate in online learning via videos and other specified sources for activities outside the classroom. According to the findings of research by [22], most students who participate in blended learning have a favourable opinion toward the blended learning model. According to the research findings by [16], the combination of learning in person and online results in a more engaging lecture format.

Because there is no physical presence of lecturers while students are studying online outside of the classroom, this might worry students. Students may wonder whether or not they are learning the material properly. In blended learning, students need to have the motivation to finish their tasks [23]. Therefore, the learning process has to be thoughtfully developed with the students' motivation in mind. Scheduled activities on the Teams platform have the potential to boost student motivation via increased engagement and involvement [24]. This is made possible when problem-based learning is included in blended learning. Before attending the classroom, students may prepare by studying the materials provided in the form of videos, audio, or other digital files, which can be accessed at any time and from any place outside the classroom. These educational resources may be made available to students through online delivery. Within the context of the activities, conversations may be carried out via Teams. For students to participate actively in the in-class activities, the lecturer gives them problems and assignments to complete.

They were incorporating problem-based learning into blended learning. As a consequence of blended learning [25,26], learning also incorporates the benefits of active learning in the classroom as a result of (PBL) and active learning outside of the classroom as a result of Teams. In addition, active learning took place as a direct result of problem-based learning. Students actively engage in the learning process by taking part in a wide range of activities as part of active learning, a technique for learning developed in the 26th century. Assignments both in and outside the classroom that forces students to work on or create something, giving projects that are to be done in groups, or involving students in supporting their peers who are having problems learning are all great ways to foster active learning. Meetings in the classroom or debates on platforms may be opportunities for active learning [27]. Developing active learning in an online learning environment may be accomplished via the use of a variety of tactics, including the creation of a learning community, the use of an online tool for interaction (Teams), and the provision of time for response and contribution. Active learning may be encouraged via online learning since students often take the initiative to seek material on the internet to finish their assignments [28]. And engage in intellectual discourse with other students or teachers over the internet. (PBL) into blended learning may be successful in enhancing student learning results since it helps reduce cognitive load [23]. [PBL] stands for problem-based learning. Students are dropping out of computer programming classes because they find the material too challenging, even though the country needs computer programmers. Students, instructors, and researchers will all benefit from this study because it will provide light on how to teach challenging topics like computer programming using a hybrid of problem-based learning and traditional classroom instruction.

1.2 Research questions

This research aimed to investigate the impact of combining problem-based learning, also known as PBL, with blended learning to improve students' fundamental programming abilities while they are enrolled in programming classes. Students are exposed to new topics before they enter the classroom via the use of videos, texts, and other resources accessible on the Teams platform. Additionally, students take a series of short quizzes to gauge their level of understanding of the content. As a direct consequence of this, in-person courses are used only for the purpose of problem-solving (PBL). This research will evaluate how incorporating project-based learning (PBL) into blended learning environments might help students improve their fundamental programming abilities. The current research endeavored to find an answer to the issue that was posed about the impact that combining PBL and blended learning would have on college students.

The following research topic was investigated over the course of the study:
RQ1. What is the primary impact that was incorporating problem-based learning (PBL) and conventional lecture methods (TLM) into blended learning has on the improvement of students' fundamental programming skills?

2   Method

In this research, the pre-test and post-test quasi-experimental designs were employed in the quantitative aspect of the investigation. The study was used in the University Programming Course. Students majoring in computer science are expected to take introductory classes covering programming principles. This class is available during the first semester of the academic year.

2.1 Design of the research

Implementing project-based learning (PBL) into blended learning using the Teams Platform to improve students' fundamental programming abilities consisted of four steps. These stages were carried out in the appropriate order. Figure 1 depicts these steps in full detail for your viewing pleasure.
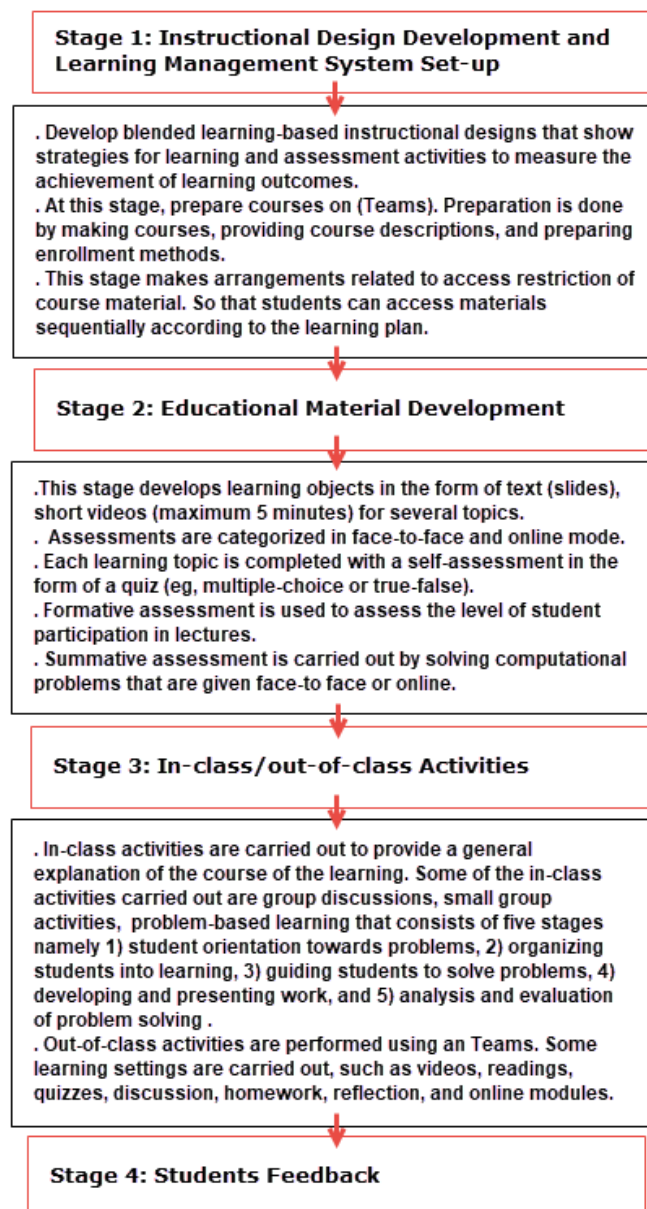
Stage 1: Instructional Design Development and Learning Management System Set-up

. Develop blended learning-based instructional designs that show strategies for learning and assessment activities to measure the achievement of learning outcomes.
. At this stage, prepare courses on (Teams). Preparation is done by making courses, providing course descriptions, and preparing enrollment methods.
. This stage makes arrangements related to access restriction of course material. So that students can access materials sequentially according to the learning plan.

Stage 2: Educational Material Development

.This stage develops learning objects in the form of text (slides), short videos (maximum 5 minutes) for several topics.
. Assessments are categorized in face-to-face and online mode.
. Each learning topic is completed with a self-assessment in the form of a quiz (eg, multiple-choice or true-false).
. Formative assessment is used to assess the level of student participation in lectures.
. Summative assessment is carried out by solving computational problems that are given face-to face or online.

Stage 3: In-class/out-of-class Activities

. In-class activities are carried out to provide a general explanation of the course of the learning. Some of the in-class activities carried out are group discussions, small group activities, problem-based learning that consists of five stages namely 1) student orientation towards problems, 2) organizing students into learning, 3) guiding students to solve problems, 4) developing and presenting work, and 5) analysis and evaluation of problem solving .
. Out-of-class activities are performed using an Teams. Some learning settings are carried out, such as videos, readings, quizzes, discussion, homework, reflection, and online modules.

Stage 4: Students Feedback

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

2.2 Sample/ Participants

One hundred students in their first semester in the computer science degree made up the study's population for the research. Learning is accomplished by the use of problem-based learning that is included in the Blended Learning platform with the Teams. Everyone who participated in the study was given prior notice about how the data gathered will be used for research purposes. The protocol for the investigation is presented in Table 1, which may be found here.

Table1. The research design is symbolically illustrated

Pre-test	Treatment	Post-test
O1	PBL into Blended Learning	O2
O1	TLM	O2

Information:

O1: A diagnostic exam to determine the level of academic achievement before therapy is administered
O2: Post-test to assess the learner's accomplishments after the therapy has been administered

2.3 Instrument(s)

In order to gather data for the research, the instrument that was designed and employed was used. The Programming Achievement Exam (PAT) is an objective test that consists of multiple-choice questions. It is made up of forty (40) different objective exam questions with multiple-choice answers. Each question on the exam is followed by a set of answer alternatives labeled A through D. The student is tasked with selecting the appropriate response from among these options. Remembering (knowledge), understanding (comprehension and application), and Thinking were the levels of cognitive do-

mains that were addressed in the test material for the research. The levels of cognitive domains that were included in the test content (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

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 investigation was conducted over a period of eight weeks. Before the beginning of training, students in both the experimental group and the control group were given a preliminary test of the PAT. Before commencing the experiment proper, the pre-primary treatment's objective was to ascertain the level of previous knowledge by the students who were a part of both the experimental and control groups. The researcher responsible for instructing the students in the control group employed the time-honored practice of giving lectures, sticking to an instructional plan that had been created in advance within the scope of the research being conducted. In a nutshell, the instruction in the control group was mostly carried out by the instructor, and learning was restricted to the actual classroom setting.

The instructional lesson plan that was put into place in the control group was different from the instructional lesson plan that was put into place in the experimental group with regard to the presentation. In the group that served as the control, the presentation was identical to the usual, customary activities. The researcher in the control group structured the whole class as a unit, making notes on the whiteboard regarding concept definitions and asking students researcher-directed questions. Students then discussed the ideas and provided examples of their own. Most of the time spent instructing the students in the control group consisted of the researcher asking questions and providing explanations, after which the students in that group engaged in discussions and received training. In a nutshell, the instruction in the control group was mostly driven by the interests of the researchers, and learning was restricted to the classroom. Teaching in the classroom was provided to the control group twice a week for a total of one hour for each session.

The experimental group's seats were positioned in a semicircle so that the researcher could move freely around the room and all participants could see the blackboard before the PBL into Blended Learning implementation began. Like the placebo group, the experimental group split their weekly time period into two sessions of 60 minutes each. The PBL process adopted by the PBL into Blended Learning group consisted of the following five steps[27]: I orienting students toward problems, (ii) organizing students into learning, (iii) guiding students to solve problems, (iv) developing and presenting work, and (v) analyzing and evaluating problem-solving. As can be seen in Figure 2, students in the PBL into Blended Learning-ing approach were given assignments in each of the subjects covered that required them to use the Teams platform as part of their research and preparation for the lecture that would demonstrate the Live coding approach..
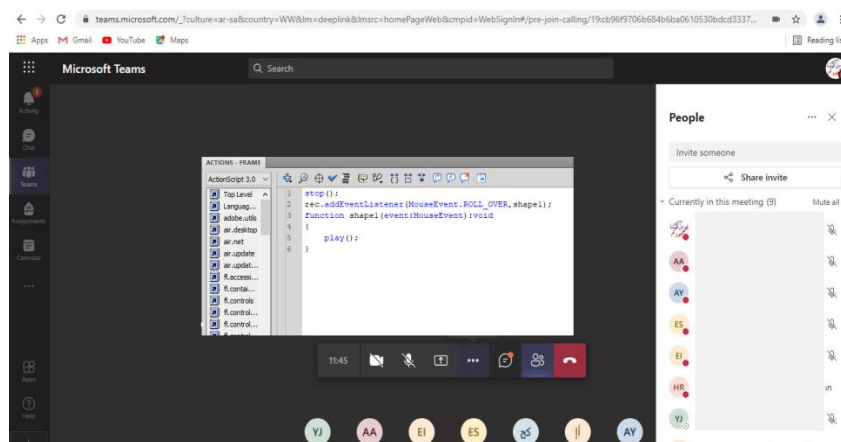
Fig. 2. Teams application used in PBL into blended learning.

After seven weeks of classroom instruction, the PAT post-test was given to students in the last week of class. Note that in order to prevent familiarization with the pre-test, a reorganized version of the pre-test was utilized for the post-test. The eight weeks of fieldwork are summarized in Table 3.

Table3. Field work Activities

Week	Activities
1st	The selection and instruction of research assistants in the administration of instruments, the selection of groups, the classification of groups into experimental and control groups, and the random selection of intact groups. Students' sensitivity will be raised.
2nd	PAT was administered as a pre-test to both the experimental and control groups.
3rd, 4th, 5th,6th, 7th	Implementation of training packages in experimental and control groups, with instruction in the experimental group incorporating PBL into Blended Learning and instruction in the control group using TLM.
8th	PAT administered as a post-test to both the experimental and control groups.

2.5 Data analysis

Analyzing the quantitative data obtained from PAT using the descriptive statistical tool of means and standard deviations was accomplished utilizing this method. This research compared the participants' performance in programming courses before and after receiving therapy, comparing their results in the experimental group to those in the control group.

3 Result

This study aims to investigate the primary impact that problem-based learning (PBL) integrated with conventional lecture methods (TLM) has on improving students' fundamental programming abilities. The fact that the value of t in the previous table is not statistically significant indicates no statistically significant difference between the average scores of the two groups on the pre-test. This finding substantiates the assertion that the two groups possess equivalent levels of expertise with regard to the programming curriculum.

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			

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			

The findings, which can be seen in Table 5 above, indicated that there was a statistically significant, at the 0.05 level of significance, return to the primary impact of therapy on the academic performance of the students. The traditional lecture method (TLM) group had a mean post-test score of 26.20, whereas the PBL into Blended Learning group had a mean score of 36.02, with a standard deviation of 1.15. The PBL in Blended Learning group had a higher mean score than the TLM group. According to these findings, the students who participated in the PBL into Blended Learning group reported a large difference in their accomplishment in programming courses compared to their peers who participated in the TLM group. This is consistent with the hypothesis that learner-centered instructional methodologies have the potential to boost students' academic performance [29], as well as the accomplishment levels of participants in the current research [30] in relation to programming classes.

4 Discussion

In the beginning, there was a strong focus on selecting groups with similar qualities in terms of age, language, and other aspects. This was done so that any significant visible difference in the mean post-test scores of the two groups on the PAT could be assigned to the intervention rather than to chance. This was done to guarantee that any such difference could be attributed to the intervention. This laid the groundwork for the subsequent discussion of the results in connection to the previously indicated research question one and hypothesis, both of which were investigated in the phase of the present study that came before it. During interviews, it was found that: (1) Students believe that the training that is provided to them is sufficient for them to acquire the necessary skills; (2) The lecture with the live coding method in Teams is understandable; and (3) Students had difficulties while working on class assignments, but they were able to overcome these difficulties because they could receive direct assistance from the lecturer. In addition, pupils did not experience feelings of hopelessness since the presence of the lecturer served to assist them.

The data indicated a substantial main impact of therapy on students' performance in introductory computer programming courses. The findings showed that when students were exposed to the teaching style of Integrating PBL into Blended Learning, as opposed to the conventional lecture method, they chose tough activities over simple ones, which drove them to study

more. This outcome lent credence to prior research linking learner-centered teaching strategies with enhanced performance learning[16, 23]. Learner-centered pedagogical practices also contributed to dispelling misunderstandings about programming, lending credence to this theory [31].

This research shows that compared to the conventional approach, including PBL in blended learning improves students' ability to learn how to code. This proved that the educational resources created on the Teams platform helped students succeed. The findings revealed that both groups of pupils improved their abilities, but the experimental group improved more. Furthermore, the data demonstrated that the experimental group had higher post-test averages than the control group. The conventional approach to education has long been criticized for putting the needs of the instructor ahead of those of the pupils it was supposed to help [13]. Blended Learning with PBL was shown to be helpful in this research in fostering programmers' abilities since it enabled students to combine in-person instruction with the flexibility of the Teams platform. Furthermore, there was evidence that students' knowledge of programming was enhanced by their time spent learning it online. Both proponents of PBL and Blended Learning supported the finding that students exposed to PBL inside Blended Learning fared better in programming, indicating that the method benefited in improving students' programming abilities. Blended Learning with PBL integration was shown to be successful in increasing students' programming competence since it allowed them to combine their offline and online learning experiences. PBL into Blended Learning advocates were vindicated by the results they saw in their classrooms when they found that students who had been exposed to the method had improved their programming abilities [32]. PBL into Blended Learning pupils, among others, were shown to have higher achievement in [33]. A similar finding was made in [34], where it was discovered that students incorporated PBL into Blended learning because they appreciated its student-centered features, such as information searching, group collaboration, and the material's personal significance.

5 Conclusions

This study has shown the effectiveness of integrating PBL into blended learning in promoting students' achievement in programming. Therefore, this strategy should be used in the teaching and learning of programming courses.

6 References

[1] A. Prasad, K. Chaudhary, and B. Sharma, "Programming skills: Visualization, interaction, home language and problem solving," *Education and Information Technologies,* vol. 27, no. 3, pp. 3197-3223, 2022.

[2] O. H. Lu, J. C. Huang, A. Y. Huang, and S. J. Yang, "Applying learning analytics for improving students engagement and learning outcomes in an MOOCs enabled collaborative programming course," *Interactive Learning Environments,* vol. 25, no. 2, pp. 220-234, 2017.

[3] C.-W. Tsai, L.-Y. Lee, H.-W. Tang, C.-H. Lin, and L. C. Hsu, "Applying web-mediated co-curricular learning and phenomenon-based learning to improve students' programming skills and self-efficacy in an online programming course," *Universal Access in the Information Society,* pp. 1-14, 2022.

[4] Y.-T. Lin, M. K.-C. Yeh, and S.-R. Tan, "Teaching Programming by Revealing Thinking Process: Watching Experts' Live Coding Videos With Reflection Annotations," *IEEE Transactions on Education,* 2022.

[5] C.-S. Chang, C.-H. Chung, and J. A. Chang, "Influence of problem-based learning games on effective computer programming learning in higher education," *Educational Technology Research and Development,* vol. 68, no. 5, pp. 2615-2634, 2020.

[6] I. Alshaye, Z. Tasir, and N. F. Jumaat, "The conceptual framework of online problem-based learning towards problem-solving ability and programming skills," in *2019 IEEE Conference on e-Learning, e-Management & e-Services (IC3e)*, 2019: IEEE, pp. 1-4.

[7] R. Kladchuen and J. Srisomphan, "The Synthesis of a Model of Problem-Based Learning With the Gamification Concept to Enhance the Problem-Solving Skills for High Vocational Certificate," *International Journal of Emerging Technologies in Learning,* vol. 16, no. 14, 2021.

[8] S. Suhirman, Y. Yusuf, A. Muliadi, and S. Prayogi, "The effect of problem-based learning with character emphasis toward students' higher-order thinking skills and characters," *International Journal of Emerging Technologies in Learning (iJET),* vol. 15, no. 6, pp. 183-191, 2020.

[9] A. Ghoniem and E. Ghoniem, "Inducing competence-based assignment in traditional structural engineering education: A case study," *Computer Applications in Engineering Education,* vol. 30, no. 3, pp. 907-916, 2022, doi: https://doi.org/10.1002/cae.22493.

[10] A. Chorfi, D. Hedjazi, S. Aouag, and D. Boubiche, "Problem-based collaborative learning groupware to improve computer programming skills," *Behaviour & Information Technology,* pp. 1-20, 2020.

[11] A. Banic and R. Gamboa, "Visual design problem-based learning in a virtual environment improves computational thinking and programming knowledge," in *2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR)*, 2019: IEEE, pp. 1588-1593.

[12] V. Y. Hikmawati and Y. Suryaningsih, "Implementing blended-problem based learning through Google classroom in biology learning," *JPBI (Jurnal Pendidikan Biologi Indonesia),* vol. 6, no. 2, pp. 217-224, 2020.

[13] O. Ojaleye and A. O. Awofala, "Blended Learning and Problem-Based Learning Instructional Strategies as Determinants of Senior Secondary School Students' Achievement in Algebra," *International Journal of Research in Education and Science,* vol. 4, no. 2, pp. 486-501, 2018.

[14] A. Efendioglu, "Problem-based learning environment in basic computer course: pre-service teachers achievement and key factors for learning," *Journal of International Education Research (JIER),* vol. 11, no. 3, pp. 205-216, 2015.

[15] M. Tayebinik and M. Puteh, "Blended Learning or E-learning?," *Tayebinik, M., & Puteh, M.(2012). Blended learning or E-learning,* pp. 103-110, 2013.

[16] A. Nurkhin, K. Kardoyo, H. Pramusinto, R. Setiyani, and R. Widhiastuti, "Applying blended problem-based learning to accounting studies in higher education; Optimizing the utilization of social media for learning," *International Journal of Emerging Technologies in Learning (iJET),* vol. 15, no. 8, pp. 22-39, 2020.

[17] T. Krasnova and I. Vanushin, "Blended learning perception among undergraduate engineering students," *International Journal of Emerging Technologies in Learning (iJET),* vol. 11, no. 01, pp. 54-56, 2016.

[18] Y. Zhang, F. Rebrina, F. Sabirova, and J. Afanaseva, "Blended Learning Environments in Inclusive Education at the University," *International Journal of Emerging Technologies in Learning (IJET),* vol. 15, no. 21, pp. 145-161, 2020.

[19] N. Kuzmina, D. Kochkina, and M. Kuzmin, "Blended Learning as a Means of Foreign Students' Integration into a University Educational Process," *International Journal of Emerging Technologies in Learning,* vol. 16, no. 6, 2021.

[20] J. Bowyer and L. Chambers, "Evaluating blended learning: Bringing the elements together," *Research Matters: A Cambridge Assessment Publication,* vol. 23, no. 1, pp. 17-26, 2017.

[21] T. Jiajia and L. B. Ayob, Research on blended teaching of English interpretation in vocational colleges under the background of informatization " *Journal of Language and Linguistic Studies,* vol. 17, no. 4, pp. 1956-1963, 2021, doi: 10.52462/jlls.141

[22] H. Karaaslan and N. Kılıç, "Studentsâ€™ attitudes towards blended language courses: A case study," *Journal of Language and Linguistic Studies,* vol. 15, pp. 174-199, 2019, doi: Doi:10.17263/jlls.547699.

[23] S. Kardipah and B. Wibawa, "A Flipped-Blended Learning Model with Augmented Problem Based Learning to Enhance Students' Computer Skills," *TechTrends,* vol. 64, no. 3, pp. 507-513, 2020.

[24] R. A. Sahulata, G. T. C. Hambali, and M. C. S. Daka, "User Satisfaction Analysis on Microsoft Teams and Google Classroom as E-Learning Media Using the E-ServQual Method," *8ISC Proceedings: Technology,* pp. 15-24, 2022.

[25] H. Ismail, A. Khelifi, and S. Harous, "A Cognitive Style Based Framework for Usability Evaluation of Online Lecturing Platforms-A Case Study on Zoom and Teams," *International Journal of Engineering Pedagogy,* vol. 12, no. 1, 2022.

[26] H. M. Hsbollah and H. Hassan, "CREATING MEANINGFUL LEARNING EXPERIENCES WITH ACTIVE, FUN, AND TECHNOLOGY ELEMENTS IN THE PROBLEM-BASED LEARNING APPROACH AND ITS IMPLICATIONS," *Malaysian Journal of Learning and Instruction,* vol. 19, no. 1, pp. 147-181, 2022.

[27] D. Divayana, "The implementation of blended learning with Kelase platform in the learning of assessment and evaluation course," *International Journal of Emerging Technologies in Learning (iJET),* vol. 14, no. 17, pp. 114-132, 2019.

[28] M. L. Kovarik, J. K. Robinson, and T. J. Wenzel, "Why Use Active Learning?," in *Active Learning in the Analytical Chemistry Curriculum*: ACS Publications, 2022, pp. 1-12.

[29] V. K. Ceylan and A. E. Kesici, "Effect of blended learning to academic achievement," *Journal of Human Sciences,* vol. 14, no. 1, pp. 308-320, 2017.

[30] C. Karaca and M. A. Ocak, "Effects of Flipped Learning on University Students' Academic Achievement in Algorithms and Programming Education," *International Online Journal of Educational Sciences,* vol. 9, no. 2, 2017.

[31] V. Ramasamy *et al.*, "Meta-analysis to study the impact of learning engagement strategies in introductory computer programming courses: a multi-institutional study," in *Proceedings of the 2021 ACM Southeast Conference*, 2021, pp. 40-46.

[32] M. A. Almulla, "The efficacy of employing problem-based learning (PBL) approach as a method of facilitating students' achievement," *IEEE Access,* vol. 7, pp. 146480-146494, 2019.

[33] Y. Yennita and A. Zukmadini, "Problem-based learning (PBL) and blended learning in improving critical thinking skills and student learning activities in biochemistry courses," in *Journal of Physics: Conference Series*, 2021, vol. 1731, no. 1: IOP Publishing, p. 012007.

[34] S. O. Asmi, S. Wonorahardjo, and H. R. Widarti, "The application of problem based learning assisted by blended learning in atomic spectroscopy material on cognitive learning outcomes and students'self system based on marzano taxonomy," *European Journal of Open education and E-learning Studies,* 2019.