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The Effectiveness of Online Collaborative Learning towards Programming Skills among Undergraduate Students in Learning Programming

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ABSTRACT

Programming skills are very crucial for the students who want to land their future career in software development field. Many methods are done to increase the programming skills among the students. Therefore, this research was conducted to study the effectiveness of online collaborative learning towards programming skills among undergraduate students in learning programming. A quantitative research design, a pre-experimental study of a one-group pre and post-test method is employed in this research. 30 undergraduate students who were taken programming course in a public institution in Pulau Pinang were selected by using the purposive sampling technique. Data were obtained by using pre and post assessment tests. Paired samples t-test was conducted to determine the effect of online collaborative learning on students' programming skills. The results indicate a significant difference between programming score before the treatment (M=63.53; SD=19.83) and programming score after the treatment (M=92.43; SD=8.14); [t (29) = 11.38, p = .001]. In conclusion, this study revealed that an online collaborative learning is effective towards students' programming skills among undergraduate students in programming course.

Contribution/Originality: The paper's contribution addresses the importance of integrating teaching and learning method into an online learning environment. The paper highlights the benefit of online collaborative learning towards students' programming skills among undergraduate students in programming course.

1. Introduction

Software programmers are in a great demand as the end uses for software are increasing day by day. The IT students are expected to graduate with great technical and professional skills in order to make sure that they will be able to compete and get a place in the industries (Yeom et al., 2022). To deal with that, colleges and universities are playing

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important roles in providing the best methods for the students to gain the necessary skills and knowledge to fulfil the requirements and needs expected by the industries out there (Yeom et al., 2022). There are a lot of approaches taken by the universities to make sure that they able to produce a number of IT graduates that are skillful and can serve in the industries with their knowledge. Among the students who are majoring in software programming, learning programming may be boring especially for those who are not so into it and find it difficult (Li et al., 2021). Hence, it is very crucial for the universities to make sure that the students able to focus in the process of learning and engaging well during class.

There is a dramatically increase in the number of colleges and universities that offering the software engineering course due to its popularity recently. Nevertheless, there are still many complaints made by the employers saying that the graduates do not have the necessary skills needed (Azmi et al., 2015). Director of Student Affairs Development in the Ministry of Higher Education Malaysia argued that graduates lacked problem solving ability (Rodzalan et al., 2015). If this problem is not resolved, it will lead to the increasing number of unemployed graduates in the future (Rodzalan et al., 2015).

Since the programming courses are also quite challenging especially for those undergraduate students who are still new to the course, it is quite difficult to develop the fundamental programming skills among them (Garcia et al., 2021). It also may cause the students to not be able to achieve the learning objectives for that course if they need to learn and complete tasks assigned to them individually (Yeom et al., 2022). To solve this issue, collaborative learning has been introduced in most of programming courses where there are a lot of projects and assignments need to be completed in a form of groups (Yeom et al., 2022).

Collaborative learning is a pedagogical approach of that use groups to intensify learning through collaboration. With any tasks assigned to the students, they will work together in groups of two or more to solve the problems. Two heads are better than one, to motivate the students and nurture their outcomes of learning in programming, collaborative learning is advocated to be an adequate method (Echeverria et al., 2017). With collaborative learning, it helps to encourage the students to have a positive attitude towards their peers and learning, and it can deepen their understanding, improve the teamwork, problem solving ability and cognitive strategies. Collaborative learning can be considered as an effective way to assist the students to resolve difficult learning challenges with support of peer (Yeom et al., 2022).

The purpose of this research is to study the effectiveness of online collaborative learning towards problem solving ability and programming skills among undergraduate students in learning programming. It is also aimed to prove whether collaborative learning can be a good practice for the students to foster their skills in terms of problem solving and programming.

1.1. Research Objectives

The objectives of the research are:

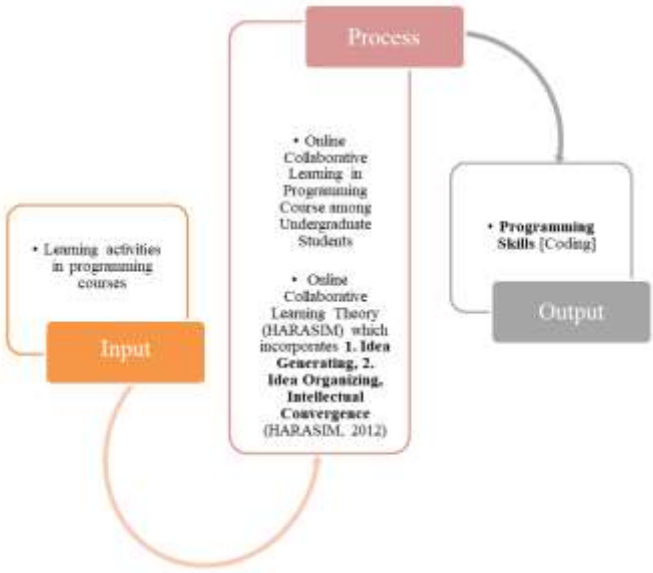
i. To design and develop an online collaborative learning environment to undergraduate students who are learning programming.
ii. To study the effectiveness of online collaborative learning towards programming skills among undergraduate students in learning programming.

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1.2. Conceptual Framework

The conceptual framework explains generally about the research done. Figure 1 shows the conceptual framework for this research study.

Figure 1: Relation of Variables in the Study



Conceptual framework classifies the variables of the research study into three main categories, which include input, process and output. Input involves the learning process done in programming course. The learning process can be conducted either face-to-face among the lecturers and students in the classroom or via online. Usually during the learning process in programming course, the lecturers will explain about the general usage of the programming language like syntax, output, variables, data types, operators, methods and many more. In programming, the students need to practice to able to gain the skills learned. In class, the lecturers usually will be giving any kind of related situation and demonstrate on how to apply programming skills to solve the situation. After that, the students must try to apply what they have learned to solve the task assigned to them by the lecturers. The tasks assigned to the students can be done individually or in a group, depending on the lecturer's instruction. In this research, we will be focusing on the tasks done by the students by using collaborative method.

Process involved the online collaborative learning in programming course among undergraduate students. For this part, the researcher is referring the theory introduced by Harasim (2012) which is Online Collaborative Learning (OCL). According to the theory, there are three phases of knowledge construction through discourse. They include idea generating, idea organizing and intellectual convergence (Harasim, 2012).

1.2.1. Idea Generating

In this phase, the brainstorming activity is being done. It is done to gather the divergent thoughts within the group. When the students are assigned any task to be done by the lecturers, they will first need to brainstorm what is the task about and what is the opinion of each member regarding the task given then they will need to gather the information to be used for the next phase.

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1.2.2. Idea Organizing

This is a phase where the students will compare, analyze and categorize the ideas that are generated in the previous phase. They will organize the generated ideas through discussion or argument. They will gain the new understanding to solve the assigned task for them.

1.2.3. Intellectual Convergence

In this phase, the intellectual synthesis and consensus including agreeing to disagree will occur. Normally it will be done through joint construction of piece of work, such as essay or assignment. Based on the task and observation done, they will collaborate to complete the tasks together.

The final conceptual framework is the output, where based on the collaborative learning done during the teaching and learning, how it will affect programming skills in terms of coding among the students. In terms of studying the effectiveness of online collaborative learning towards programming skills among the students, the researcher will be focusing on the improvement of their coding skills only. Their coding skills might be improved if the approach being used is suitable with what they are currently learn.

2. Literature Review

2.1. Computer Programming

Computer programming is known as the process of writing instructions for a computer to execute. The instructions, or also called as code, are written in programming language that computers can understand to perform the tasks or solve the problems. Basic computer programming involves analyzing the problem and developing a logical sequence of instruction to solve it. There can be many possible paths to a solution, and computer programmers try to design and code the most effective way. A programmer's responsibilities include understanding requirements, determining an appropriate programming language, designing or drafting a solution, coding, testing, debugging and writing documentation to make it easier for other programmers to understand the solution (Yeom et al., 2022). The processes involved in programming are accordingly almost similar to those that are involved in problem solving, for example, applying algorithms, decomposing problems, abstracting, and automatizing (Scherer et al., 2020).

Computer programming is the central to computer science. It is the software development, application development and implementation part of software development that transforms ideas and theories into real working solutions. Computer programming is a fusion of art and science. It is technical and analytical, but creative at the same time (Azmi et al., 2015). There are several programming languages that are used by the programmers across the globe to write the code such as C, C++, Java, Javascript, Python and SQL. Programming language is a computer language that are used by the programmers to specify the behavior of computer, application or software program. It is written in specific language to perform a specific task. Many programming languages are used to write the computer programs.

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2.2. Programming Skills

For most of the students that starting out in this field, learning computer programming is actually a difficult task. In fact, many students point out that learning computer programming is a tedious and tough task, creating a certain amount of anxiety when dealing with these issues (Terroso & Pinto, 2022). There are many challenges faced by the students in learning computer programming.

One of the main challenges faced by the students especially novice programmers is to find the solutions to the proposed problems. Younger viewers, on the other hand, are used to clicking icons and seeing applications with great interfaces. Therefore, students who are proposing the solutions are often demoralized when they need to implement an algorithm in the classroom to classify numbers or strings and print them out. It can also be unattractive development environment. Another aspect that promotes some demotivation among the students is the lack of instantaneous feedback on what they proposed. This is because the students often do not have a genuine idea of where they went wrong or how to refine the solutions they have presented (Terroso & Pinto, 2022).

Syntactic, strategic and conceptual knowledge are interrelated to each other, and students often have difficulty to establish themselves with conceptually and strategically knowledge. To improve the lack of syntax knowledge, compiler or modern integrated development environment can be used, as these tools can detect any error in the code. On the other hand, Strategic and conceptual are quite challenging as it relates to general and logic problem-solving ability that is based on the knowledge of syntax (Yeom et al., 2022).

Other than that, students often fail to engage with the instructions and feedbacks given to them during programming learning process. During the learning process, feedback from the instructors or lecturers is very important as they can guide the students, criticize their progress and answer any question that the students may have. However, if the instructors are having low knowledge of the content or they are using problematic teaching strategies, they might mislead the students. Rather than trying to understand the concept, many students always try to memorize it instead. Therefore, it is very crucial for the instructors to apply effectual strategies of teaching and tools to deal with the difficulties faced by the students during learning process of programming. It is also very important to come up with learning supports for the students that influences them to participate in the learning process and reduce cognitive lead (Yeom et al., 2022).

2.3. Online Collaborative Learning

Collaborative learning is an educational method that uses groups to enhance learning process via collaboration. Normally there will be groups of two or more learners working together to complete tasks, solve problems and learn new concepts. Rather than memorizing facts and numbers, this method is actively encouraging the learners to process and synthesize information and concepts. It has been proposed as an approach that can help to improve students' motivation and learning outcomes (Yeom et al., 2022).

In collaborative learning, learners work together in a group on projects that require them to understand the presented concepts. By preserving their positions, reframing ideas, listening to other people's point of views, and clarifying others' point of views, learners will be able to gain a broader understanding as a group than as individuals.

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Collaborative learning is applied in various IT fields. Collaborative learning reportedly could encourage the learners to have a positive attitude towards learning, which resulting in having deeper understanding, and they able to improve their teamwork, cognitive strategies and critical thinking. As for the learners who are facing the difficulty to solve learning tasks, collaborative learning is an effective way for them to do with the support of the peers. Collaborative learning also not limited to face-to-face learning in classroom, but also can be conducted online. The most common tools that are used in today's education to facilitate collaborative learning are Google Meet, Microsoft Teams, Zoom, and Padlet. In stated collaborative tools, students are able to conduct group discussion and do many activities together online (Yeom et al., 2022).

3. Research Methodology

3.1. Research Design

A quantitative research method by using a pre-experimental one group pre and post-test research design will be employed in this research study. There is no treatment group involved to avoid the communication that might occur among the control group and treatment group. Quantitative data will be obtained by assessment tests. The result from the assessment tests and PSI will be analyzed and presented in tabulated data and statistical value.

3.2. Population and Sample

The population of this research study is consisting of a batch of undergraduate students who are currently enrolling in programming language course in a public institution in the Northern Region of Malaysia. Meanwhile, the sample of this research study is consisting of 30 undergraduate students who are currently enrolling in programming language course in a public institution in the Northern Region of Malaysia. The sampling technique used in this research study is purposive sampling.

3.3. Research Instrument

3.3.1. Pre and Post Assessment Test

Pre and Post Assessment Test is the instrument that is distributed to the students who are the sample of the research before and after the intervention is conducted. The assessment test for both pre and post will have the same questions and is aimed to study the mean difference between the students' programming skills before and after the online collaborative learning is conducted. The assessment test consists of 15 questions and is divided into three parts. There will be five multiple choice questions, five true and false questions, and five short answer questions that require the students to write their answers. The students will be tested on Web Programming subjects that are focusing on three types of programming languages which include HTML, Javascript and CSS. Every question will be given one mark, hence the total marks for the assessment test is 15.

4. Research Findings

Analysis of Effectiveness of Online Collaborative Learning towards Programming Skills Among Undergraduate Students in Learning Programming

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The second objective of this research is to study the effectiveness of online collaborative learning towards programming skills among undergraduate students in learning programming. In order to do that, the researcher prepared a set of assessment test questions to be answered by the students before and after intervention is done. The test question is created with the goal to test the understanding of the students on Web programming, a programming course that they are currently enrolling.

To investigate the effectiveness of online collaborative learning environment done in this research study towards programming skills among undergraduate students in learning programming, the researcher analyze the pre and post-test assessment results of the 30 students by using two methods, descriptive and inferential analysis. There are 15 questions in both assessments. The total marks for the assessment test for both pre and test are 100%. Pre and post assessment are using the same set of questions, aiming to study the improvement of the students before and after they complete activities done in the online collaborative learning. Table 1 shows the details of the marks obtained by the students in pre and post-test assessment.

Table 1: Statistical Analysis of Pre and Post Assessment Test

No.	Student	Pre-Test (100%)	Post-Test (100%)	Marks Difference (Post – Pre)
1	S1	93	100	7
2	S2	87	100	13
3	S3	33	80	47
4	S4	80	100	20
5	S5	87	100	13
6	S6	27	73	47
7	S7	87	100	13
8	S8	60	87	27
9	S9	73	93	20
10	S10	60	87	27
11	S11	73	93	20
12	S12	80	100	20
13	S13	73	100	27
14	S14	67	100	33
15	S15	47	80	33
16	S16	53	87	33
17	S17	73	93	20
18	S18	60	93	33
19	S19	67	100	33
20	S20	53	87	33
21	S21	67	93	27
22	S22	67	100	33
23	S23	67	93	27
24	S24	73	100	27
25	S25	40	87	47
26	S26	33	80	47
27	S27	13	87	73
28	S28	53	80	27
29	S29	93	100	7
30	S30	67	100	33
Mean		64	92	-

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Descriptive analysis is done to show the marks difference in pre and post-test assessment of the students. The mean for each assessment test is also calculated. Based on the statistical analysis of the pre and post assessment test in Table 1, the lowest mark in pre-test assessment is recorded by S27 who obtained 13%, meanwhile S1 and S29 recorded 93% which is the highest mark in pre-test assessment. In post-assessment test, there are 13 students who are scoring 100%, which is the full and highest mark. The lowest mark obtained in post-test assessment is 73%, recorded by S6.

All 30 students are showing improvement in post-test assessment after intervention since as all of them able to score higher marks than during pre-test assessment. S27 shows the highest improvement which is 73% of marks difference between pre and post-test assessment. S27 shows a very good improvement where the student actually goes from 13% in pre-test assessment to 87% in post-test assessment. The second highest of marks difference is recorded by S3, S4, S25 and S26 which is 47%. There is no decline of marks from pre-test to post-test assessment among 30 students.

Other than descriptive analysis, the researcher also analyzes the data of pre and post-test assessment by using inferential analysis. In order to evaluate the effectiveness of online collaborative learning towards programming skills among undergraduate students in learning programming, data obtained need to be analyzed to find the mean difference of students' marks between pre-assessment test and post-assessment test. Inferential analysis is done in version 27 of SPSS. There are two hypotheses identified in this research study:

H0: There is no significant mean difference of students' marks between pre-assessment test and post-assessment test.
H1: There is significant mean difference of students' marks between pre-assessment test and post-assessment test.

Before deciding on what kind of test to be used to analyze the date, normality test is done. It is to determine whether the data is normally distributed or not.

Table 2 shows the result of normality test that is done on the pre and post assessment test data. In order to determine the normal distribution of the data, Skewness and Kurtosis value must be in the range of ±2. Based on the data, Skewness values for pre-test and post-test are -0.723 and -0.711, respectively. Meanwhile, the Kurtosis value for pre-test is 0.248 and Kurtosis value for post-test is 0.427. For this data, the researcher is choosing Skewness values to determine the normal distribution of the data. Since both Skewness value for pre-test and post-test are within the range of ±2, it can be concluded that the data is normally distributed. Hence, Paired Sample T-Test which is used to evaluate the mean difference between two treatment conditions by using data from single sample, is selected to analyze the data.

Table 2: Normality Test

	N	Minimum	Maximum	Mean	Std Deviation	Skewness	Kurtosis
PreTest	30	13.00	93.00	63.53	19.83	-.723	.248
PostTest	30	73.00	100.00	92.43	8.14	-.711	-.567
Valid N	30						

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Table 3 shows the result of Paired Sample Statistics. Based on the result shown, the mean value of the pre-test is 63.53, meanwhile the mean value for post-test is 92.43.

Table 3: Paired Sample Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTest	63.53	30	19.83	3.62
	PostTest	92.43	30	8.14	1.49

Table 4 shows the Paired Sample Test Result. From the result above, the significance p-value is 0.001, which is lower than 0.05. Since the significance p-value is lower than 0.05, the null hypothesis is rejected. Therefore, it can be concluded that there is a significant mean difference of students' marks between pre-assessment test and post-assessment test. Hence, it can be concluded that intervention process that is done for online collaborative learning by researcher is effective towards the programming skills of the undergraduate students in learning programming.

Table 4: Paired Sample Test Result

		Mean	Std Deviation	Std. Error Mean	T	df	Sig (2-tailed)
Pair 1	PreTest – PostTest	-28.90	13.91	2.54	-11.38	29	<.001

5. Discussions

The findings of the research show that online collaborative learning is effective towards programming skills among students in learning programming. The significant mean difference of the results in pre and post assessment test is proving that there is an improvement of the students' programming skills. During the intervention, the students are learning about few topics in Javascript, HTML and CSS. The researcher prepares few video links and website content for them to view and discuss with their peers in a form of group. The students are also required to complete the task assigned to them every week. The tasks assigned to them are related to what they are provided in the video and website content which may help them to improve their knowledge and skills in programming. According to Guo et al. (2021), collaborative learning can help to yield parallel computing, quick computations and appealing the generalization ability of the students. Since they are doing the tasks in the group, the students can brainstorm the idea and guide each other to complete the task assigned to them. By doing that, they will remember things more easily and enjoy their learning process, and subsequently will help to improve their skills in programming. Therefore, it can be concluded that the online collaborative learning done is effective to help them improving their scores in programming assessment test, and at the same time help to enhance their programming skills. This finding can answer the first question posed in this research study.

6. Conclusion

The conclusion that can be drawn from the research study is that the online collaborative learning is proven to be effective towards programming skills among undergraduate students in learning programming. It can be clearly seen by the improvement of marks of

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the students in their pre and post assessment test, when they are being tested with the programming questions that comprises of HTML, CSS and Javascript type of programming languages. Hence, both instruments used in this research study are effective to identify the effectiveness of the online collaborative learning that are designed and developed for the students. Online collaborative learning can be used as one of the main methods to be used by the instructors in teaching and learning activity of programming, due to its effectiveness towards the undergraduate students.

Ethics Approval and Consent to Participate

The researchers used the research ethics provided by the Universiti Teknologi Malaysia. All procedures performed in this study involving human participants were conducted in accordance with the ethical standards of the institutional research committee. Informed consent was obtained from all participants according to the Declaration of Helsinki.

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Conflict of Interest

The authors reported no conflicts of interest for this work and declare that there is no potential conflict of interest with respect to the research, authorship, or publication of this article.

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