The Effectiveness of Blended Learning Approaches towards Achievement in Programming Skills of Secondary Students': A Case Study

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Abstract:

This study aims to examine the effectiveness of using blended learning approach in programming skill particularly in algorithm topic, for secondary students towards their achievement level. This study is quantitative in nature with an experimental quasi design. Fifty-nine students in form one who took Fundamental of Computer subject were purposively selected from school located at Kuantan district area. The students were divided into two groups, 29 students for the treatment group and 30 students for the control group. The instruments employed in this study is 2018 final exam questions using dependent t-test. The results showed that there is a significant improvement in the treatment group's achievement compared to the control group, t (28) = -23.31, p=.00, (p < 0.05. This study indicates that the use of blended learning has a positive impact on students' achievement in programming skill. Thus, the use of blended learning has the potential to improve the programming skill among students and teacher can used it as teaching strategy in school. In addition, this approach can also help students to foster lifelong learning habits by as recommended by the government and not just use them for social media activities.

I. INTRODUCTION

Implementation of Asas Sains Komputer- ASK (Fundamental of Computer subject) in in secondary school is one of the ways to introduce computational thinking to Malaysian students in order to enhance their skills in problem solving which are complex, systematic and logic (Bahagian Pendidikan Guru, 2016). The subject consists of algorithm and programming topic so that the young generation will be creative, innovative and dynamic in the era of technology. However, in the first year of implementation, a few problems related to understanding and comprehend in computer concepts arose.

Research shows thatwho are new to the concept of programming young will face difficulties when learning programming languageif the teacher adopts an existing conventional approach Bati (2015 Xinogalos (2016)István Gerják (2017). Whilst Yagci, (2016), assert that high order thinking skills (HOTS) and problem solving skills are essential in computer programming, yet both of these skills are very challenging to students.Most probably this is due to lack of exercises and reinforcement in conventional teaching

method especially related to programming concepts.To ovecome this problem, they must actively involved and need to familiarized with programming languages syntax and program writing that needs continous effortTherefore, existing learning approaches need to be integrated with online learning that gives students the opportunity to increase their understanding of the concept of programming

At the same time, result of the pilot study by the researchers also shows that students are lacking in comprehensive practical exercises at school. This problem occurs because the amount of time allotted for learning and facilitation sessions (LF) for ASK subject in schools is limited to two hours only. Similar findings were obtained from a study conducted by Nithia, Yusop, & Razak (2015) whereby teachers found it difficult to offer more time facilating to weak students especially with regard to understanding STEM concepts in the classroom due to time constraints. Therefore, they propose a learning approach that allows students to have access to teachers and teaching materials outside of class time to address the constraints of time. In addition, a study conducted by Kurniawati (2014), emphasized that students still failed to master the content of

learning as expected despite the fact that the traditional teaching and learning strategies provided at the school were good quality especially for subjects that involve a combination of theoretical and practical knowledge. As a result, the level of theoretically and practically knowledge of the students are unbalanced.

A blended learning approach is an alternative and a value addition to students in a more active learning and facilitating environment that supports the learning of the 21st century. According to Gerber, Grund and Grote (2008), students can better understand key concepts and build their knowledge when they are inside classes that incorporate online activities. Bonk and Graham (2012) and Yagci (2016) affirm that an institution can practice blended learning for pedagogical improvement by practicing it through the integration of innovative approaches to education and information technology.

Therefore, based on the issues discussed, this study was conducted to test the effectiveness of blended learning on student achievement for ASK subject for form 1 studentsin the context of Malaysian students especially at school level. In this study, researchers use several blended learning tools such as Google Classroom and existing online applications to implement blended learning methods to enhance student knowledge and interest in ASK subject.The researchers carried out this study with the following research objective, research question and hypothesis

i. Research objective: To evaluate the effectiveness of blended learning on students' academic achievement in algorithmic titles for ASK subjects compared to conventional learning practices

ii. Research Question: Does blended learning improve students' academic achievement in the algorithm for ASK subjects compared to conventional learning practices?

iii. Hypothesis:

H_o1: There is no significant difference in student academic achievement for the algorithmic titles for ASK subjects using a blended learning approach compared to conventional learning practices.

$H_1 1$: There is s significant difference in student academic achievement for the algorithmic titles for ASK subjects using a blended learning approach compared to conventional learning practices

II. LITERATURE REVIEW

Computational Thinking and Algorithm
The use of the term computational thinking (CT) was introduced by Jeannette M. Wing in 2006. Wing (2006) defines computational thinking as the means by which humans think to solve problems. Wing (2008) also describes CT as a "universal set of attitudes and skills" that covers problems, designing systems and understanding human

behavior using basic concepts of computer science. Mainly, CT requires the ability to identify appropriate algorithms (J Zepcevski, 2012). Algorithms is one of four CT components that identify by Lockwood & Mooney (2017).According to Fallis (2013), an algorithm is a recipe for solving a problem.

Thus, it can be concluded that computational thinking is the ability to apply and understand basic principles of computer science. Through computational thinking, problem-solving methods are translated into forms that can be implemented effectively using computer-based solutions. According to Selby (2014), programming skills are the specific technical skills required to produce a specific solution using a set of digital tools, often associated with programming languages. Therefore, programming is one of the key elements in the use of computational thinking and problem-solving skills.Thus, this study focuses on the application of programming concepts and limits them to algorithm knowledge as algorithms are fundamental to programming concepts and problem solving.

i. Blended Learning

Blended learning is one of many educational programs (formal or informal) that combines online digital media with existing conventional learning approaches. This approach requires the physical presence of both teachers and students with some element of student control over time (MohdAzli, Wong, Noraini, & Noh, 2016). MaizatulHayati Mohamad Orphans &UmizHusnaAzizan (2018), define five characteristics of blended learning; (a) active students, (b) students build their own knowledge, (c) Subjective, dynamic and developmental, (d) Processing and understanding of information and (e) students have their own learning.According to Kaur (2013) blended learning is a combination of a variety of effective delivery methods, teaching model and learning style which are implemented in an interactive learning environment.Yagci (2016) research finding shows a positive impact on academic achievement especially for average students. This study also revealed that passive and less active students require more online learning methods than average students.Based on the literature review, there are several examples of the model or framework of blended learning currently in use. However, according to Mirriahi, Alonzo, & Fox (2015) each framework has its own emphasis and features in keeping with the subjects and needs of the students involved.

Kurniawati (2014) propose a framework for computer subject of high school which consists several sections. Each section has its own characteristics based on a constructive approach. This framework has two main settings; synchronous and asynchronous learning. In this learning approach, students can conduct online learning sessions or use existing conventional learning methods. They are also given the option to carry out group activities that involve project-based tasks and individual tasks that can be performed on their own such as creating slide presentation. The framework is shown in Figure 1.
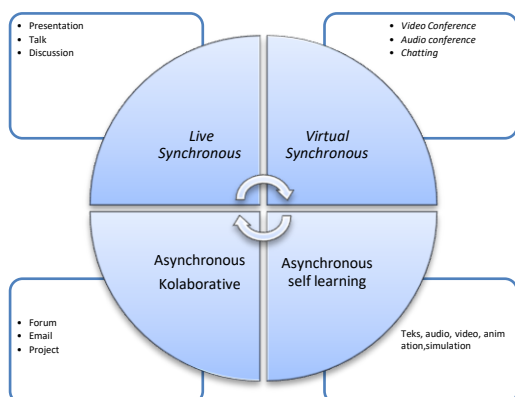
Figure 1. Blended Learning Framework by Kurniawati (2014)

Mathews (2016) propose Rotation Model for blended learning approach. The rotation modelsenable students to change the schedule or with the teacher's consent into several other modes of learning, and at least one of the modes must be online learning. Figure 2 shows Rotation model.
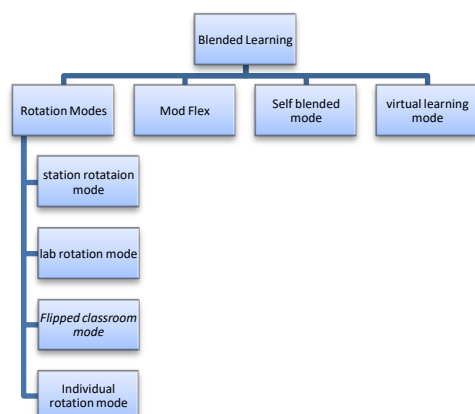

Figure 2. Rotation Model of Blended Learning Mathews (2016)

Whilst, the learning environment framework proposed by Bati (2015) is comprised of three categories: mass lectures in the auditorium, small-group laboratory activities and e-learning-based communication support. A mass lectures environment with an LCD projector and laptop for teachers aims to help group teaching. Laboratory activities for small group sizes are used to support pair programming. The e-learning platform has two functions. It is used as a resource repository, which is an e-learning system that supports information delivery and pair programming by disseminating learning notes and assessment questions for laboratory activities. Bati (2015) also proposed that e-learning systems be designed to support collaboration between students and teachers. Figure 3 shows the learning environment framework for blended learning.
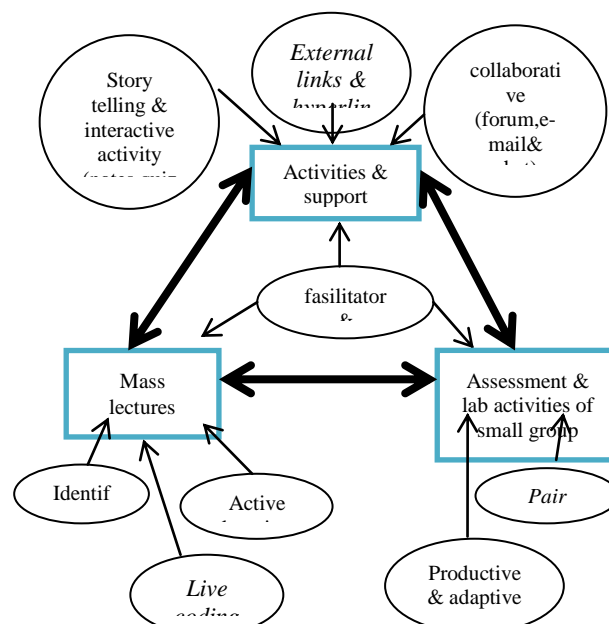

Figure 3. Blended learning framework by Bati (2015).

Based on the structure of the blended learning approach discuss above, each framework or model has different characteristics based on the goals to be achieved. However, for the study of the effectiveness of programming for ASK subjects, researchers selected the integrated support structure proposed by Bati (2015) as a guideline for the design of blended learning. This is because the framework is more detailed by incorporating small and large group learning to fit the learning environment in the laboratory and student self-learning in the school and at home. In addition, the framework is designed to be tested for students who are new to programming concepts.

Collaborative Learning in Blended Learning

Social constructivism that is closely linked to blended learning is collaborative learning. According to MaizatulHayati Mohamad Yatim & Umm HusnaAzizan (2018), collaborative learning is the development of knowledge that results from social development. In this learning approach, students need to create a learning environment that is transparent and accessible to others so that there can be good collaboration for everyone in the group. Since collaborative learning approaches are a form of group learning, interactions between group members need to be implemented in order to generate good group understanding and decision making. Sharing between groups will result collaboration holistic and tasks will be easily delegated and executed. The differences and similarities between collaborative learning and blended learning can be summarized as shown on Table 1.

Table 1
Differences and similarities between collaborative learning and blended learning

Collaborative learning	Blended Learning
Change idea actively	Promote learning in more depth
Increase motivation	Increase motivation
Promote critical thinking	**Promote critical thinking** and knowledge development
Enhance communication and dynamic	Enhance communication skill and connection with other students
Improve attitude towards learning such as responsibility	A greater sense of responsibility for one's own learning
Encourage students to beself-directed learner	Encourage students to be self-directed learner

Therefore, by integrating a blended learning approach, which is to integrate a collaborative learning approach in the classroom and an online learning approach outside the classroom in a blended learning approach, students become more active and can encourage them to engage in cooperative learning groups. In addition,enhancie students' critical and creative thinking within a given area of study.

III. METHODOLOGY

Research Design
This study aimed to examine the effectiveness of blended learning approach to students in understanding the programming concept. Therefore, the selected methodology is a quantitative study using quasi-experimental methods. Quasi-experimental design is used when the subject or respondent of the study cannot be randomly selected (Privitera&Ahlgrim-Delzell, 2018). According to Baker (2017), most educational research is unable to randomly select subjects or respondents due to constraint of students' time table and their classes. Whilst, Ali and Zulkifli (2016) emphasize that this technique is useful for testing differentiation effects in a variety of situations where the 'pure' experimental technique is completely impractical especially in the actual study. Therefore, the researcher chose to conduct this study using the quasi-experimental post-test and pre-test technique with control and treatment respectively as shown in Table 2.

Table 2
Experimental Quasi Research Design

Group	Treatment
G_T	O_1 X_1 O_2
G_C	O_3 _ O_4

G_T	:	Treatment Group
G_C	:	Control Group
X_1	:	Blended Learning Approach
_	:	Conventional Learning Approach
$O_1 = O_3$	:	pre-test
$O_2 = O_4$	:	post-test

An independent variable in this study is the type of treatment, which is a blended learning approach conducted on the treatment group**.** Whereas the control group (G_C) conducts existing conventional learning and the dependent variable is measured on the achievement of the students in the test.Before the treatment, both group students, G_T, G_C were asked to seat for pre-test. The purpose for this test is to identify the level of students' knowledge in algorithm topic before the treatment. After the pre-test, treatment of using blended learning approach in teaching and learning algorithm was given for five weeks to the samples ofG_T.Meanwhile, teaching and learning was done using conventional approach is done for samples in $G_C$for the sametopic. At the end of week five, after the duration of treatment is finished, both groups need to take post-test.

Teacher selection for this study was through a voluntary process in which of the two teachers teaching elementary students, only one teacher participated in the study. Selected teacher is given a detailed description by the researcher and one training day (after school session) before the actual study begins. The training is conducted to ensure that teacher understand the whole process and attempt to carry out the teaching and learning process within the framework of the study. Therefore, the external variables in this study were minimized by controlling the learning concept that covered the same topic for both treatment and control groups. In addition, lesson plans for blended and conventional learning are also provided by researchers in order to control the quality of teaching for both groups.

Prior to conducting the actual study, permission is applied from the Education Policy Research and Development Division (EPRD), Ministry of Education Malaysia (MOE) to conduct the study based on the selected time and state and subsequently applied for follow-up at the Pahang State Education Department and the involved school. Lastly, discussion was held between teachers and students.

Population and Sampling
The study was conducted in a district in the state of Pahang. District selection in the is done based on the simple sampling concept. Only one district in the state of Pahang was chosen because the other districts could not fulfil the requirement of research framework such as internet facilities in a school and at home. This is supported by Huang, Yang, & Chen (2015) who stated that simple sampling is suitable if there is flaw in sampling framework.

A homogeneous sample of 59 secondary school students were selected from two classes who took ASK (intact group) using purposive sampling using existing students in the class as the number of students could not be adjusted due to school administration and policy reasons. Table 3shows number of samples of each group.

Table 3
Samples of study for each group

	Number of samples based on class and gender				N
	Class	Boys	Girls	Total students	
Treatment Group	A	13	16	29	59
Control Group	B	13	17	30	
Total		26	33	59	

Instrument

The instrument used to collect data are pre- and post-study scores. Topic algorithm is taken for testing because algorithms are fundamental to programming skills and due

Week	Sub topic	Conventional	Online
1	Introduction to algorithm development. Writing pseudocode & drawing flowchart for sequential of structure for problem solution	Introduction to algorithm development.	Story telling & interactive activities (interactives notes)
2	Writing pseudocode & drawing flowchart using selection control structure for problem solution	Learning activities Group activities (problem solving)	Collaborative (forum &*google drive*) Quiz & problem solving using online
3	Writing pseudocode & drawing flowchart for repetition vontrolstructure for problem solution.	Learning activities *Pair programming*	*External links & hyperlink* (media link such as *YouTube*&*www.draw.io* Individual assignment
4	Identify errors in pseudocode and flow chart of the problem solution	Learning activities *Live coding (scratch)*	Collaborative Learning activities (*google classroom*) Group assignment Creating slide presentation
5	Writing pseudocode and drawing flowchart for selection & repetition control structure of problems solving	Learning activities Slide presentation	Quiz & reinforcement exercise (*google classroom* dan *google drive*)

to time constraints whereby for this topic alone, duration is five weeks. The pre-test and post-exam questions consist of eight structural questions from the final exam questions in 2018. These questions are based on the test specification table (TST), Curriculum and Assessment Standard Document (DSKP) for ASK subject.

Data Collection Procedure

To answer the research question, the study was conducted for five weeks of teaching and learning for both groups. Pre-test and post-test were done before and after the treatment. Figure 4 shows summary of data collection procedure of the study.
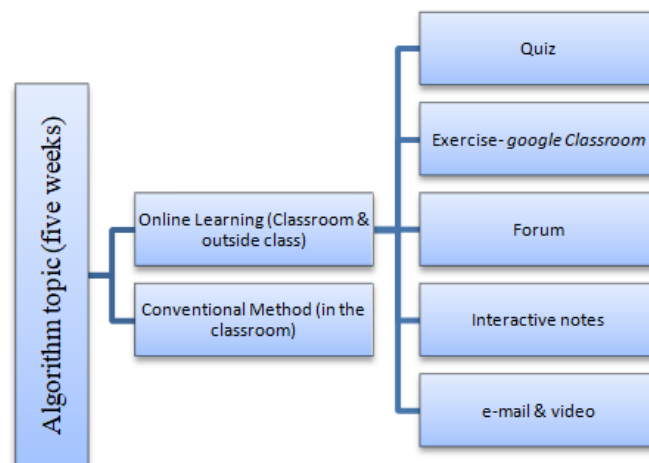

Figure 4. Summary of data collection procedure

In addition, teacher was provided with lesson plan for the conventional method for both group and extra learning materials for the blended learning approachto the treatment group. The blended activities are planned using framework proposed by Bati (2015). The treatment groupteaching and learning process is shown in Figure 5. Whilst the teaching and learning activities are shown in Table 4.
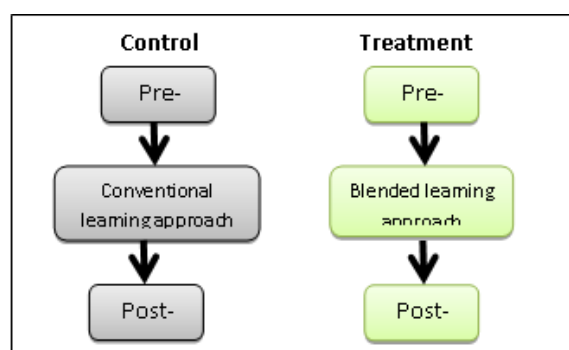

Figure 5. Summary of data collection procedure

Table 4
Blended learning approach activities planning for five weeks

IV. FINDING

Research Question: Does blended learning improve students' academic achievement in the algorithm for ASK subjects compared to conventional learning practices?

To answer the above research question study, the score of pre-test and post-test based on algorithm topic were taken. Based on Figure 5, result shows the students' prior knowledge for the topic Algorithm in ASK subjects for both groups is homogeneous and normally distributed. This can be seen from the results of the study that showed that students only obtained grades D, E and F for both groups. Figure 6 shows the score of pre-tests of both groups.

Figure 6. Score comparison between control group and treatment group

Based on Table 4, Dependent t-test was conducted to compare differences in students' academic achievement in the algorithm topic using a blended learning approach with conventional learning approach. The results showed that there was a significant difference and improvement from the pre-test score (mean = 34.62, sp = 8.97) to the post-test score (min = 86.52, sd = 7.22, t (28) = -23.31, p = .00, p <0.05) for blended learning approach and from pre-test scores (mean = 31.87, sd = 9.29) to post-test scores (min = 51.03, sd = 15.60, t (29) = -10.09, p <0.05 for conventional learning approach.

Table 4
Dependent t-test – Pre-test score and Post-test score between control group and treatment group.

Group		N	Mean	Standard Deviation	df	t	Sig.
Control Group	Pre-test	30	31.87	9.29	29	-10.09	.00
	Post-test	30	51.03	15.60			
Treatment Group	Pre-test	29	34.62	8.97	28	-23.31	.00
	Post-test	29	86.52	7.22			

Thus, the null hypothesis was rejected H$_o$1: There was no significant difference in students' academic achievement for algorithmic titles for ASK subjects using a blended learning

approach compared to conventional learning practices.On the other hand, the alternative hypothesis was accepted that H$_A$1: There is a significant difference in student academic achievement for the ASK subject algorithm using a blended learning approach compared to conventional learning practices.

Moreover, based on Table 5, the descriptive statistical analysis of the t-test showed that the mean score for the treatment group using the blended learning approach was significantly higher (mean = - 51.90, sd = 11.99), compared to the control group score value using the practice of learning. conventional (min = −19.17, sd = 10.4). Thus, these results indicate that the implementation of a blended learning approach to the treatment group (G$_T$) has increased student achievement in Algorithm topic compared to control group (G$_K$) using conventional learning approach. Therefore, the blended learning approach provided is effective in enhancing students' knowledge in Algorithm topic of the treatment group.

Table 5
Dependent t-test Descriptive Analysis Statistic

Approach	N	Mean	Standard Deviation
Conventional	30	-19.17	11.99
Blended Learning	29	-51.90	10.41

In addition, there is wide discrepancy between student's grading in both groups. Figure 6 shows quite high increment in the number of students with grades A, B and C and a decrement in students with grades D, E and F for the treatment group compared to the control group as shown in Figure 7.
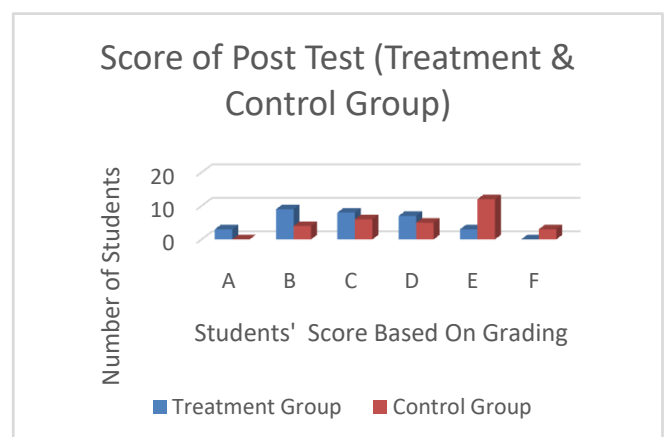

Figure 7. Students' Grades Comparison Between Treatment Group and Control Group

V. DISCUSSION

The assessment conducted on the form-one students shows that the level of effectiveness of their programming skills is enhanced when teachers use a blended learning approach in teaching and facilitating sessions (TF). This can be seen through the findings of the study which show the difference in the number of grades obtained between classes using the existing conventional learning approach and the classroom using the blended learning approach. Although there is an increase in mastery of student academic achievement in the algorithms for students using conventional learning and blended learning approaches, it is clear that the increase in students' use of blended learning approaches is significantly higher than that of students using conventional learning approach.

This is due to the use of various forms of technology media that interest students to understand and implement programming training. This is in line with the findings of Yagci (2016) which show that the use of technological approaches in discussion and training improves students' understanding compared to existing conventional discussion methods. The combination of various media and learning techniques helps students to understand programming concepts easily. The use of these various media has become a source of reference and additional information to the students has helped students master the programming skills. Through this study, students were introduced to a variety of online sources that were found to be able to provide additional insight into the concept of programming. This finding is in line with the findings of Van Niekerk and Webb (2016) and Bati (2015). They explicate that through blended learning approach, students can access various resources that can enhance their understanding of learning. This is because the source of information available to students is not tied to what the teacher is telling in the classroom alone but also outside the classroom. In addition, students also can explore various resources available on the internet such as YouTube and online applications which are available such as Google Classroom. This type of learning not only enhances students' understanding of a topic, but it also opens their minds that the internet is a great resource for a variety of topics and subjects. However, this approach needs to be coordinated and monitored by teachers to ensure that pupils achieve the specified learning objectives as suggested by Kotsopoulos et al., (2017).

Next, the choice of tools in the blended learning approach is also one of the factors that influence the effectiveness of this approach to students. MaizatulHayati and Ummu Husna, (2018) recommends using a user-friendly tool. The use of user-friendly tools not only helps students to learn and understand easily but it also helps teachers to provide more effective learning materials. In addition, it will save teachers time to guide students in using it. As we all know, there are a variety of tools that can be used to enhance students' understanding of programming, but teachers need to choose according to the level of ability of students to use them. more effective learning (MaizatulHayati&Ummatian, 2018).

In addition, it will save teachers time to guide students in using it.

As we all know, there are a variety of tools that can be used to enhance students' understanding of programming, but teachers need to make wise choices in terms of their ability to use it. Throughout the study, there were several tools were used in implementing blended learning, but some of students found it difficult to use it. As a result, teaching process in the classroom took longer than the time given because teachers had to spend more time to guide students using tools. Therefore, teachers should consider several factors in determining the tools used in blended learning. First and foremost, teachers need to know the existing knowledge of the student regarding the use of the tools whether or not they know how to use it. If the teacher does not have time constraints and students are unfamiliar with it, then the teacher may introduce the new tools as it can a new knowledge for them. However, if there are time constraints, then teachers need to look for alternatives. Secondly, teachers also need to know the level of knowledge of students in using the tools they have chosen, in terms of their usability. This is because unfriendly application or toolswill cause students to become bored and will not continue learning. Therefore, teachers need to be prepared with ICT skills and technology in order to make the maximum impact in teaching and learning based on teaching technology as suggested by Bahador, Othman, and Saidon (2018). Moreover, they must have technological pedagogical content knowledge (TPCK) so that the integration of teaching technologies in the classroom would become more meaningful. In line with the 21st century education system, teachers' TPCK needs to be dynamic, evolve with students' or technological changes.

Furthermore, results fromthis study also shows that time constraints of teaching and learning in schools can be overcome using blended learning approaches as suggested by (Kurniawati, 2014). In addition, it also helps students who are absent. Students who are unable to attend school for any reason may still be able to follow and carry out the exercises provided at home and may continue to be reviewed by the teachers at the school. During the period of the study, five students were involved in co-curricular activities outside of school, yet by using blended learning, the students were able to follow the lesson and did the exercises provided. The test results of these students indicated that the learning objectives for this topic were achieved as they were able to answer well in the test. This is in line with the findings of the study by Dan, Information, Xi, Smk and Purwodadi (2014) which shows that blended learning can help improve students' self-directed learning to be more organized and effective. Therefore, blended learning can also be used as an alternative to the TL approach for students who are active in sports or other school activities, or for students with health problems who cannot attend school. However, teachers need to monitor and provide guidance so that these students can learn without any misunderstandings.

Lastly, by integrating technology, students can learn on their own by accessing the material at any time they want based on the flexible features concepts that come with it. This enables students to engage with existing resources at their own pace and to help them become more independent in their learning process (Yagci, 2016). For weak students, they can repeat the content of the lesson with the help of a video from a teacher. Whereas for excellence/intelligence students, they are given access to advanced materials that can be used to understand a topic in greater depth. This can assist teachers in achieving the teaching objectives of the whole student even when the achievement of these objectives differs between one student and another.

Although there are many advantages using blended learning, there are weaknesses that need to be considered also when implementing this blended learning. Students tend to hang loose and difficult to perform at home on time. This is due to the absence of teachers to monitor students while they are at home. This is also possible due to the unclear and detailed instructions of the teacher. This is in line with the findings of Xinogalos (2016) that students find it difficult to achieve the learning objectives when they are at home. Therefore, there is a need for online learning guidelines and frameworks that need to be integrated with a face-to-face learning approach in the classroom so that students are constantly monitored and supervised by teachers to ensure that the learning objectives are met in the allotted time. At the same time, parent's involvement in this approach also is very important because they can monitor their child at home and ensure their child do tasks that are given.

VI. CONCLUSION

The research findings show significant improvement in student academic achievement in ASK subjects for algorithmic topics through a blended learning approach compared to conventional learning approach. Blended learning provides a more flexible space where it provides more space for learning at any time. This approach is an innovation that can not only be used as a teaching approach of Computer Science teachers but can also benefit students. The practice of teachers always adopting a conventional approach to learning in the classroom can be improved by incorporating two forms of learning that can change students' perceptions of programming concepts and thus improve their computational skills. Lastly, by implementing blended learning in the school level, students are expose to the concept of 'self-directed -learning" which are important when they pursue their studies atuniversity because at the university level, pedagogical approaches are not fully implemented. In addition, this approach can also teach studentsto use online sources as medium for learning and instead of using it for social media activities only which will indirectly foster lifelong learning habit as recommended by the government.

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