Higher Order Thinking Skills Based Learning

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Higher Order Thinking Skills Based Learning Outcomes Improvement with Blended Web Mobile Learning Model

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The objective of this research is to analyze the effectiveness of the blended web mobile learning model in improving Higher Order Thinking Skills-based learning outcomes of high school students. This research is a quasi-experiment design. The research sample was 37 students from 2 senior high schools in East Java Province - Indonesia. Before implementing the BWML model using MoLearn, both groups of students were tested (pre-test) and after the learning was complete, students were again given the same test (post-test). The collected data were analyzed using the Wilcoxon test; calculation of n-gain; and the Mann-Whitney U test. The results shows that biology learning using the BWML Model is effective in improving student learning outcomes as indicated by: (1) an increase in student learning outcomes which is statistically significant at α=5%, (2) the average of n-gain is in the medium category, and (3) the mean of n-gain has no difference in the two groups of students.

Keywords: learning outcomes, HOTs, blended learning, BWML model, learning

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INTRODUCTION

The implementation of information technology in the field of education has become increasingly prevalent recently, especially in using internet as a learning medium. E-learning is considered as one of the most suitable information technology solutions in learning (Caporarello, 2014; Gong, 2018). According to Hariadi (2015) the presence of information technology has made the emergence of computer-based learning in the form of web-based teaching environments such as computer-based learning (CBL), web-based learning (WBL) and web-based teaching (WBT). On the other hand, Hariadi's (2015) research findings suggest combining online learning model and face-to-face learning in the form of blended learning. Combining face-to-face learning and web-based learning (blended learning) can improve learning outcomes. The quality of the process and student learning outcomes are directed at achieving higher-order thinking skills (HOTs) in the industrial era 4.0. This is by the learning objectives contained in the provisions of the IQF and the demands of the 2013 curriculum. The achievement of HOTs is an important focus, as stated by Jatmiko et al. (2016), Pandiangan et al. (2017) and Sunarti et al. (2018) that Indonesian education is currently faced with important problems, i.e how to increase higher order thinking skills (HOTs). The 2013 curriculum requires HOTS-based 21st century learning so that students have superior competencies with various skills that are in line with the 21st century and the 4.0 industrial revolution demands (Hariadi et al., 2019). The implementation of blended learning is to meet the needs of graduates in the era of industrial revolution 4.0 which is directed at HOTs and learning innovations, including: creativity, collaboration, critical thinking, literacy, problem-solving skills, decision making, taking responsibility, and being able to learn independently (Pingan et al., 2017; Jatmiko et al., 2018; Prahani et al., 2018)

The next technological development that has penetrated the education field is the presence of Android-based smart phones. This technology makes it easier for Generation Z to access their needs regarding communication in various directions through social networks (Hariadi, 2017). Generation Z is a generation that is born and raised when there is information technology. Generation Z according to Hariadi et al. (2016) is a generation who is comfortable and dependent on technology, always connected to social networks and can multitask with various online products. With the characteristics of generation Z, the use of android as a learning medium is an alternative that can be considered seriously.

Blended Web Mobile Learning (BWML) is a learning model that integrates two models. Integration between the Hybrid Learning Model and the Problem Based Learning Model where every learning process is supported by the use of the MoLearn application (Hariadi et al., 2019). MoLearn is a learning application developed to accommodate teachers, students, sources and other learning media. The MoLearn application was developed in two versions, namely web-based and android-based (Hariadi et al. 2019; Sunarto et al., 2017; Lemantara et al., 2018; Hariadi et al. 2017). This model was developed to make it easy for teachers and students in learning process by utilizing information and communication technology as well as an answer for generation Z so that they can keep learning using their gadgets (Hariadi et al., 2017).

Based on the development of various learning models, especially the development of the BWML Model to complement the MoLearn application as an application with a blended learning approach and as a means of meeting the needs of learning technology that is suitable for students as Generation Z, it is necessary to measure the level of effectiveness. The MoLearn application has been built and tested in high schools starting from 2017 and in 2019 it has undergone improvements to suit the needs of teachers and students. In August 2019, trials were carried out on 8 high schools in the regions of East Java – Indonesia, and and generate positive responses from both users and reviewers in the fields of education and Information Technology (IT), as well as from educators, who hereinafter in this article are referred to as teachers and from learners, later in this article called students. The MoLearn application prioritizing ease of access, between teacher and student interactions, the interaction between students, and supported by the breadth of learning resources, in addition to the ease in the learning evaluation process in the form (online exams with time restrictions, task collection processes, and attendance discipline), assessments that can be seen by students, and an emphasis on the honesty of collecting students' works (Hariadi et al., 2016). Until now no research discusses the application of MoLearn to improve student learning outcomes, therefore the purpose of this research is to analyze the effectiveness of the BWML model in improving high school students' HOT learning outcomes.

Literature Review

MoLearn

MoLearn in this article is a term taken from a combination of the words between Mobile and Learning. Mobile learning can be defined as a wireless electronic device that is small and portable, such as mobile phones, smartphones, personal digital assistants (PDAs), personal computers (PCs), and small tablets that can be used with flexibility and interactiveness in learning (Bucharaey & Altaher, 2017). Mobile learning in general can be defined as learning through mobile devices; this is possible because of the presence of mobile devices that permit learning beyond the classroom walls (Bora & Dhumane, 2012). This mobile learning is the third wave of learning with information technology, as the first and second waves are desktop computers. One of the main reasons for using mobile learning is because of its availability and ease of access (Sarrab et al., 2012). Bucharaev and Altaher (2017) concluded that "mobile learning has many advantages when used during the learning process, besides that it has a cheaper economic price, and is efficient, fast in terms of accessing material (text or files), and is easy to obtain and use without limitation. by time and right". This is reinforced by Bora and Dhumane (2012) who state that mobile learning can encourage student participation in face-to-face learning using mobile phones. This mobile learning can be used to perfect and complement face-to-face learning in class (Sarrab et al., 2012). The use of mobile learning in face-to-face learning can be called as blended-learning (Hariadi et al., 2019). In this article, the term of MoLearn in question is a blended learning-based application that has been designed by researchers of Universitas Dinamika and has a copyright and trademark from the Director General of IPR, hereinafter referred to as the MoLearn Application. This MoLearn application has two versions, namely the web version and the Android version which can be accessed by installing the application via Google Play or Play Store (Hariadi et al., 2019).

Higher Order Thinking Skills (HOTs)

Higher Order Thinking Skills (HOTs) are the measure of learning achievement. HOTs-based learning outcomes are student learning outcomes that involve high hierarchical cognitive level thinking activities from Bloom's thinking taxonomy. Hierarchically, the Bloom's taxonomy indicators for HOTs-based learning outcome include analyzing (C4), evaluating (C5), and creating (C6) (Anderson and Krathwohl, 2001; Anggraini et al., 2019; Tanujaya et al., 2017). High-level thinking is one of the changes that the education system must have, especially in the world of industrial revolution 4.0 today. as the curriculum system in Indonesia demands that students be able to improve HOT according to the objectives of the KKNI and the 2013 Curriculum (Sunarti et al., 2018; Jatmiko et al., 2018; Prahani et al. al., 2018; Suyidno et al., 2018). Resources that have high integrity and the ability to process in the 4.0 century will make the world of education able to compete globally. Where the skills needed in the 4.0 industrial revolution include the 4Cs (Creativity, Critical, Collaboration, Communication) and are supported by the ability to make decisions, take responsibility, and solve problems (Pandiangan et al., 2017; Sunarti et al., 2018; Jatmiko et al. ., 2018; Prahani et al., 2018; Suyidno et al., 2018; Grifin & Care, 2015; Kusuma, et al., 2017). Several studies have detailed these HOTs into several indicators to measure their achievement. The ability to analyze (C4) is further broken down into the ability to analyze factual, conceptual, procedural, and metacognitive knowledge. The ability to evaluate (C5) is further broken down into the ability to evaluate factual, conceptual, procedural, and metacognitive knowledge. The ability to create (C6) is further broken down into the ability to create conceptual, procedural, and metacognitive knowledge (Kusuma, et al., 2017). High-level thinking skills need to be trained so that students' achievement can be improved. HOTs-based learning outcomes are related to intelligence and achievement indexes achieved by students. Students who have HOTs tend to have high achievement indexes and vice versa, students who do not have (lack of) HOTs tend to have low achievement indexes (Tanujaya et al., 2017).

Blended Learning

Mobile learning is wireless electronic devices that are small and portable, such as mobile phones, smartphones, personal digital assistants (PDAs), personal computers (PCs), and small tablets that can be used flexibly and interactively in learning (Tim Brilian, 2015). Suana et al. (2017) call blended learning as a learning combination from two historically separate learning models, namely a combination of face-to-face learning model and online learning model. In general, blended learning is a learning strategy that combines face-to-face learning and learning that utilizes information technology such as online learning, computer based learning (CBL) and other information and communication technology-based learning media (Tim Brilian, 2015; Lalima & Dangwal, 2017). The research findings show that blended learning methods and strategies are effective in increasing learning motivation and learning outcomes of English (Cao & Liu, 2017; Wichadee, 2017). In addition, blended-learning can also increase satisfaction in learning, provide challenges and increase student interest in learning (Banyen, 2016). The advantages of blended learning in providing learning challenges, increasing student interest, motivation, and learning outcomes as the findings of several studies above show that blended learning is an interesting learning strategy to be developed with a variety of learning models in the future.

MoLearn as an Application in Blended Learning

The MoLearn application is an electronic learning application that has been developed by several researchers in Indonesia, especially the Dynamics University. Apart from being a means to facilitate access to the learning process for teachers and students, this application is used to assist students in creating HOT learning outcomes at the high school level. This application is designed in two forms, namely in the form of a web and in the form of an android. Blended learning is one type of MoLearn application development, which can be accessed without the time and place limits so that the learning process can be done virtually and without face-to-face unlike classroom learning (Suartama, 2019; Banyen, 2016; Lalima & Dangwal, 2007). 2017). As several learning models in revolution 4.0 emphasized that students are the center of learning, the MoLearn application also has a role that teachers become facilitators, and students as learning centers. Where the teacher only guides and gives direction so that students always play an active role (Hariadi et al., 2019). In the web version of the MoLearn application, the initial appearance of the web version can be seen in Figure 1.

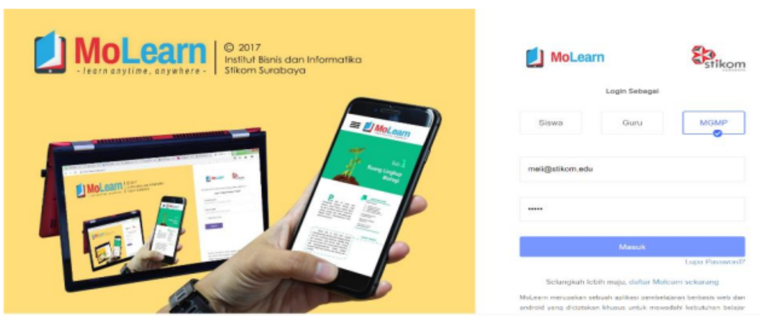

Figure 1
Initial display of MoLearn in web version

To be able to use this MoLearn application, users must log in first. On this login page, user must select user's authority whether as MGMP, Teacher, or Student, followed by entering user ID and password. After successful verification, user will be prompted to choose the subject to be followed in this application. Furthermore, users can enjoy this web version of the MoLearn application according to their authority. In the Android version of the MoLearn application, the initial display of the app can be seen in Figure 2.

Figure 2
Initial display of MoLearn in android version

As in the web version, in this Android version user is also asked to log in first by determining user's authority whether as MGMP, Teacher, or Student, followed by entering user ID and password. In general, the appearance of the web and the Android version is almost similiar, the difference is just that the Android version does not provide menu to fill in data of school, teacher and student, content and some large data that because it will make it difficult for users. But menus to see data and teaching materials and to provide comments on assignments, assessments and discussions are available as in web version. After user is verified and accepted, then he/she can use this MoLearn application and will enter the initial display of selecting subject.

Blended Web Mobile Learning (BWML) Model

The learning model is a framework that is used as a reference in compiling the learning process by involving several phases. Each phase that exists in each type of learning model is composed of several indicators, where the indicators are strategies, methods, and ways to convey the learning process that has been designed systematically. The type of learning model can be seen in its constituent indicators. Blended Web Mobile Learning (BWML) is a learning model that integrates two models. Integration between the Hybrid Learning Model and the PBL Model where each learning process is supported by the use of the MoLearn application (Hariadi et al., 2019). Blended learning is one type of MoLearn application development, which can be accessed without the time and place limits so that the learning process can be done virtually and without face-to-face unlike learning in class. On the other hand, blended learning itself is learning that combines face-to-face learning with learning using ICT. Thus the BWML model is blended learning between face-to-face and online, while online learning also combines the web version and the Android version. The MoLern model of learning is based on leading learning theories, namely the theory of constructivism, observation, discovery, cognitive processes, and the latest theories (Hariadi et al. al., 2019b). The BWML model has five phases, namely (a) Internet of Things (IoT) and Big Data-Based Orientation, (b) Investigation, (c) Analyzing, (d) Presenting, and (e) Evaluating. Each of these phases has been integrated with the MoLearn application.

METHOD

This research is a quasi experimental design (Fraenkel & Wallen, 2009) with the following design:

O_1 X O_2

O_3 C O_4

Description:
O1: the pretest score of the treatment group before learning (pre-test),
X: learning with the BWML model
O2: the final test score of the treatment group after learning (post-test)
O3: the pretest score of the untreated group before learning (pre-test)
C : conventional learning (not the BWML model)
O4: the final test score of the untreated group after learning (post-test)

The research was conducted at two high schools, namely SMAN 6 Surabaya and SMAN 2 Jombang with a sample of 137 students from 209 populations. Samples were obtained using the following formula: [population / (1 + e2 x population)] with error tolerance e = 5%. Each high school was divided into two groups, namely the experimental group that gets learning treatment with the BWML model using the MoLearn application and the control group which carried out conventional learning (without the MoLearn application). The details of the research sample are as in Table 1.

Table 1
Number of research samples

School	Treatment Group	Control Group	Total
SMAN 6 Surabaya	35	35	70
SMAN 2 Jombang	35	32	67
Total	70	67	137

The research was initiated by developing biology learning tools in the form of: Semester Learning Plans (*Rencana Pembelajaran*/RPS); Student Teaching Materials (*Bahan Ajar Siswa*/BAS); and instruments in the form of test results of biology learning. This learning outcome test consists of 1 subjective test item and 13 objective test questions with 5 (five) options: 4 (four) distractors and 1 (one) correct answer; the questions are made about the high-level cognitive domains, namely: analysis, synthesis, and evaluation. The validity and reliability of RPS, BAS, and biological test instruments are shown in Table 2.

Table 2
Validity and reliability of RPS, BAS, and biological test instruments

Learning Instrument	Validity	Category	Reliability (%)	Category
RPS	3.9	valid	96.0%	Reliable
BAS	3.7	valid	88.9%	Reliable
Test instrument	3.8	valid	95.7%	Reliable

Table 2 shows the results of the validity and reliability of the RPS, BAS, and all research instruments. All validity results are categorized as valid and reliable and show the results that all instruments are feasible to use. The experimental group and control group were given a test of biology learning outcomes before being given treatment (pre-test), then the experimental group was given learning using the BWML model using MoLearn, and in the control group learning was carried out as usual without the BWML model or MoLearn application. Furthermore, the two groups were given another learning outcome test (post-test) with the same test questions.

To analyze the effectiveness of the BWML model with the MoLern application is done by processing the data of students' pre-test and post-test scores. The process of processing and analyzing data using SPSS 24 software went through 3 stages, namely: 1) test for improving learning outcomes from two groups (experimental and control); 2) calculate the mean score of n-gain for both groups, and 3) compare and test the similarity of the mean n-gain scores of the two groups. The BWML model using the MoLearn application is said to be effective if: student learning outcomes have increased significantly at the level of α = 5%; moderate category on the mean score of n-gain, and the two groups did not have the mean n-gain differently (consistently). Then the assumption of normality was tested on the pre-test and post-test scores with the Kolmogrogv-Smirnov test and continued with the Wilcoxon statistic test. Meanwhile, the mean score of n-gain is calculated in the following categories: a) low if n-gain is .3; b) moderate if .3< n-gain <.7; and c) high if the n-gain is 0.7. and the Mann-Whitney U test tested the mean n-gain not different between the two groups. Hypotesis of this reseach:

First Hypotesis
H_o: Student learning outcomes did not increase significantly at the level of = 5%
H_a: Student learning outcomes increased significantly at the level of α = 5%

Second Hypotesis
H_o: there is no significant N-gain difference in the BWML Model and Non BWML Model classes at the level of = 5%
H_a: There is a significant N-gain difference in the BWML Model and Non BWML Model classes at the level of = 5%

FINDINGS

Data on student learning outcomes from pre-test and post-test have been obtained by researchers. Learning outcomes were analyzed both before and after being treated with the BWML model using MoLearn in both groups of students at SMAN 6 Surabaya and SMAN 2 Jombang, presented in Table 3.

Table 3
The mean of pre-test and post-test scores of two groups: SMAN 6 Surabaya and SMAN 2 Jombang

Instructional	BWML Model		Non BWML Model	
Group	Pre-test	Post-test	Pre-test	Post-test
SMAN 6 Surabaya	24.20	70.03	19.23	40.00
SMAN 2 Jombang	29.28	52.91	26.09	39.06
Mean	26.74	61.47	22.66	39.53

Table 3 shows that the means of students' biology learning outcome scores before learning both using the BWML model and the non-BWML model in both groups of students were very low, namely 26.74 and 22.66 in the score range of 0-100. After learning, the means of learning outcome scores at the group of students with the BWML model was higher than the group with the non-BWML model, namely 61.47 and 39.53, respectively.

Table 4
Wilcoxon test results of HOTs for all groups

Group	N	Wilcoxon test	
		Z	p
BWML_SMAN 6 Surabaya	35	-5.160	.00
BWML_SMAN 2 Jombang	35	-5.161	.00
NON BWML_SMAN 6 Surabaya	35	-5.162	.00
NON BWML_SMAN 2 Jombang	32	-3.756	.00

α=5%

Table 4 shows the Z scores giving a score of -5.160, -5.161, -5.162, -3.766 for all groups. From the results of the value of each group above, it shows $p < .05$, because the Z value in the table is negative, meaning that after all groups were treated with the BWML model there was an increase in the student's HOT score.

Table 5
Mann-Whitney U T-test results for mean N-gain of all groups

Group	N	Mann-Whitney U	
		Z	p
Group-1: BWML_SMAN 6 Surabaya Group -2: NON_BWML_SMAN 6 Surabaya	70	-5.885	.00
Group-3: BWML_SMAN 2 Jombang Group-4: NON_BWML_SMAN 2 Jombang	67	-2.730	.06

Table 5 shows that the Z scores for groups: 1-2 and 3-4 are -5.885 and -2.730. This shows that the mean score of n-gain is not different and is declared significant because $p < .05$. Because $p < .05$, there is a significant difference in the mean N-gain HOTs in the Group-1 BWML model with the Group-2 NON-BWML model at SMAN 6 Surabaya, the Group-3 BWML model with Group-4 NON-BWML model at SMAN 2 Jombang, each at α = 5%. The results of the analysis above show that the average N-gain HOT of students after learning the BWML model is higher than the NON-BWML model.

DISCUSSION

Based on the table Based on Table 4 and Table 5 proves that the BWML learning model is effective in increasing the HOT of high school students. This is because this model is designed so that HOT in students can develop and improve, and students can get used to thinking HOT. The novelty of the BWML Model lies in Phases 2, 3 and 4 which are described as follows. Stage 2 is an investigation, which aims to collect information using student activity sheets (LKS). In this process the teacher provides direction during the investigation process, where instructions are given step by step in using the MoLearn application. Directions are given so that students are trained in finding explanations and solutions to the problems they face, and so that students can build good learning outcomes. Stage 3 is analysis, this stage guides students to be able to think broadly about the phenomena they face, where the thinking process bridges students to be able to make correct analysis, discussion, and conclude the results of investigations appropriately. Stage 4 is Presentation, at this stage student can convey in detail the results of the investigation with good performance skills in front of other students. Through presentations, students will be carried away in a flowing discussion condition, what is presented is the analysis of IoT and Big data-based work. The findings of this research are supported by theoretical foundations, including cognitive theory which explains that learning is a relatively persistent change in mental structure that occurs as a result of an individual's interaction with the environment (Moreno, 2010; Arends, 2011; Slavin, 2011). Bandura's theory explains that social learning occurs from observing the behavior of others and the environment (Bandura. 1977). Then it is also supported by sociocognitive theory which focuses on the process of observing and analyzing the behavior of others, both in terms of expressing opinions, and reading expressions. Bruner emphasizes that constructivism through inquiry learning is more effective, such as the discovery learning model, where students can process new things through information and experiences that are known in different situations (Moreno, 2010). Shown through the attitude of active participation of students in constructing other concepts and principles into the concepts and principles themselves (Gardner, 2011).

MoLearn is one of the development applications from Blended Learning, meaning that it is an application that is used as a medium in the learning process. This application can be used in two conditions, first, the learning process is face-to-face directly with the teacher, the second is learning without face-to-face independently. The concept of Blended Learning is suitable for use with the process of using the MoLearn application, where learning can be done without being limited by time and place and in unlimited conditions as well. This means that it can be done anywhere and anytime and under different conditions (Banyen et al., 2016; Suartama et al. 2019; Lalima & Dangwal, 2017). It was supported by previous researchers that through the MoLearn application, students are the center of learning and teachers are facilitators and mentors to provide direction so that students can be active in learning (Hariadi et al., 2019). Learning tools as an operational form of the BWML Model that has been developed are also an important part of the implementation of the BWML Model assisted by the MoLearn application. It is proven in Table 4 and Table 5 that there are significant differences in the results of post-test and N-gain student learning outcomes based on HOTs, where students who have used the MoLearn-assisted BWML Model have better HOTs-based learning outcomes compared to those who did not use the Model. MoLearn assisted BWML. This result is supported by research by Hariadi et al. (2019) stated that valid learning devices can support learning outcomes.

CONCLUSION

Based on the results of the research and discussion above, it can be concluded that: learning biology using the BWML model assisted by the MoLearn application is effective for improving student learning outcomes based on HOT, indicated by: (1) an increase in HOT-student learning outcomes from both groups are significant with a level $\alpha = 5\%$; (2) obtained the medium category on the average score of n-gain for both groups; and (3) there is no difference in the mean n-gain scores of the two groups of students..

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