Embedding The Guided Inquiry On Blended Learning To Enhance Conceptual Understanding

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Abstract: The issue of understanding concepts in physics learning is continuing to be studied by educators, especially by utilizing information and communication technology. This study aims to reveal an increase in understanding of physics concepts with blended learning strategies integrated with guided inquiry models. The design of this study was a pre-test and post-test controlled group with the subject of research being eleventh-grade students in Yogyakarta, Indonesia. Online learning activities use EDMODO as a learning management system. Understanding the concept was measured using several 30 validated essays. Items validation aspects included subject matter, construction, and language. The statistical analysis used to determine the increase is to look at the category of gain value and T-test using alpha equal to 0.05. To avoid the other influenced factors, the numerical ability, verbal knowledge were used as covariate and those were analyzed the contribution using the linear regression. The results of this study indicate that blended learning by integrating guided inquiry has a better impact on understanding physics concepts**.**

Keywords: concept understanding, blended learning, guided inquiry, learning management system, learning innovation.

1 INTRODUCTION

NOWADAYS, the development of information and communication technology affects the education field in Indonesia. Technology and globalization are influencing the 21st-century education [1]. It is in line with the expectations of the 21st-century education achievement which is acquiring the capability of communication, creativity, understanding, and critical thinking that always have a place in education and takes on new meaning and relevance with the development of technology [2, 3, 4]. 21st-century learning promises that digital technologies will transform traditional learning and mobilize those skills that are necessary for an emerging digital environment [5]. In reality, physics learning in the classroom tends to be teacher-centered. The teacher gives lectures with examples of problem-solving without many dialogic activities. Besides, students experience difficulties in problem-solving related to factors determining fluid pressure and capillary in the static fluid materials. As a result, the student did not thoroughly understand the teaching materials, and it has not met the learning objectives in the 21st century. Therefore, the researchers tried to implement one of the learning models to develop potentials and student's concept comprehension. The learning model was the guided inquiry. The guided inquiry learning model is one of the learning models that emphasizes on activities [6], skills, and knowledge through active searching based on the curiosity, helping students to grow individual responsibility, cognitive method, problem-solving skills [7], investigation [8] and capability in understanding the concept [9]. The guided inquiry learning model has several obstacles in the learning implementation phases because of the limitation of capacities, services, and resources [10].

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One of the solutions to handle the obstacles of the implementation of the guided inquiry learning model is by utilizing social media. People, including teacher and student, have not used social media yet for learning because of the ignorance of the existence of social media. A variety of social media for learning have been developed and used. EDMODO as a learning platform that has some distinct advantages over traditional [11]. Such as studied the factors affecting teachers' motivation to use online teaching tools [12], ease of use; entertainment; usefulness; and self-confidence [13], as an excellent communication tool for knowledge communication through social network [14], designed for collaboration, communication, the sharing of knowledge, homework and discussion between students, teachers and parents [11]. These learning environments aim at providing a learning process that is more comprehensive than traditional approaches, and the environments require communication and technology to help new generations to learn [15]. Besides, EDMODO as the Learning Management System (LMS) has features to implement e-learning, such as can access libraries, teaching/learning materials and their pages everywhere (when at home, school, and traveling) [16]. Therefore, the implementation of the guided inquiry model is essential. The teacher arranged the learning with a different model, which is by combining learning in the laboratory-based on guided inquiry learning and online learning. In other words, it is called "blended learning." Blended learning is an integration of face-to-face and online teaching [17], an innovative concept covering the benefits of traditional teaching in the classroom and learning supported by information and communication technology including offline and online learning [18]. Through blended learning, learning system becomes more flexible and not rigid. However, teachers in Indonesia do rarely implement blended learning in their classroom, so the researchers tried to implement blended learning at school to enhance the understanding of physics concepts and to create fun, active, efficient and exciting learning for students.

2 METHOD

2.1 Research Design

This research is quasi-experimental research with pretest-posttest control group design. The research subjects were eleventh-grade students of a senior high school in Yogyakarta in the academic year of 2018/2019. The samples of this research were the eleventh grade consisting of 64 students divided into experimental and control classes. The sample taking technique was random. In this research, the experimental class used blended learning, and the control class used the conventional model. Figure 1 shows the phases of the research. To avoid the other influenced factors, the numerical ability, verbal knowledge were used as covariate and those were analyzed the contribution using the linear regression.

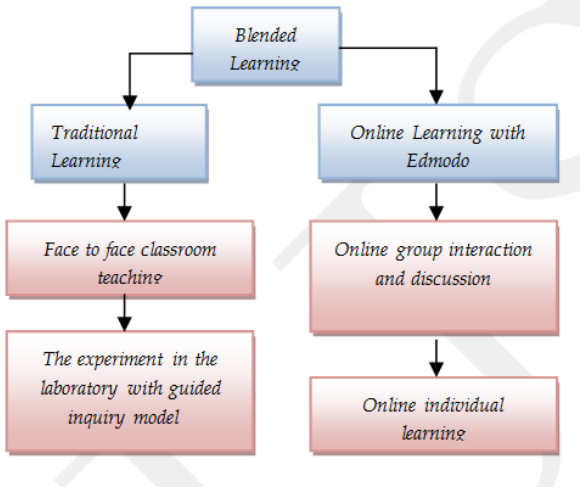

Fig. 1. *Blended learning activities based on a guided inquiry model.*

Stages in the blended learning activity

1. **Traditional Learning**
   Face-to-face classroom teaching: the teacher explained the teaching materials related to the experiment that would be carried out in the laboratory. The experiment in the laboratory with guided inquiry model: after receiving materials, students experimented in the laboratory guided by the teacher (guided inquiry model). The phases of guided inquiry covered presenting questions or problems, hypothesizing, designing experiment, conducting the experiment to get data, collecting and analyzing data, and concluding.
2. **Online learning with EDMODO**
   Online group interaction and discussion: after the practicum, students were told to submit the report of the practicum result by uploading it on EDMODO. If they found difficulties, they could also discuss via EDMODO.
   Online individual learning: the teacher uploaded materials via EDMODO. Students were told to learn the materials outside the school hours. After that, the teacher gave quizzes or exercises to evaluate the understanding of the static fluid concept.

2.2 Research Instrument

The research instruments were questionnaires and the test questions of the concept comprehension (pretest and posttest) consisting of 30 multiple choice questions that had been validated by the expert lecturers and physics teachers. Table 1 shows the rubrics of static fluid concepts.

TABLE 1
THE RUBRICS OF FLUID CONCEPTS

No	Conceptual subject items	Concept dimension			Item number
		T	I	E	Pretest and Posttest
1.	Hydrostatic pressure	√	√		1, 2 , 3, 5, 6
2.	Law of Pascal	√	√	√	7, 8, 9, 10, 11, 12
3.	Law of Archimedes	√	√	√	13, 14, 15, 16, 17
4.	Surface tension	√	√	√	18, 19,20 21, 22, 23, 24
5.	Capillary	√	√		25, 26, 27, 28,
6.	Viscosity	√	√		29, 30

2.3 Data Analysis Technique

The data analysis technique used the gain index, precondition test analysis, and ANCOVA by using Microsoft Excel and SPSS 16.0. The calculation of instrument validity of concept comprehension test used content validity by Aiken. The formulation is as follows.

$$V = \sum \frac{s}{[n(c-1)]} \quad (1)$$

where:

V = item validity index by Aiken
s = r - l_0
r = score from validator
l_0 = the lowest score in the scoring (for example 1)
n = number of the item
c = the highest score in the scoring (for example 4)

Table 2 shows the interpretation of the validity coefficient.

TABLE 2
CATEGORY OF AIKEN INDEX VALIDITY

Validity coefficient	Interpretation
> 0.35	Strongly essential
0.21 – 0.35	Essential
0.11 – 0.20	Depends on the situation
< 0.11	Not essential

The increase of concept comprehension was tested by using the difference of Ngain between pretest score and posttest score of experimental and control classes. The formulation to find the N_{gain} is as follows.

$$N_{Gain} = \frac{X_{posttest} - X_{pretest}}{X - X_{pretest}} \quad (2)$$

where:

$X_{posttest}$ = the average score of the posttest
$X_{pretest}$ = the average score of pretest

X = maximum score of the posttest

Table 3 shows the gain score standard.

TABLE 3
GAIN SCORE CLASSIFICATION

N_{Gain}	Classification
$0.70 < N_{Gain} \leq 1$	High
$0.30 < N_{Gain} \leq 0.70$	Medium
$N_{Gain} \leq 0.30$	Low

3 RESULT AND DISCUSSION

3.1 Result

The item validity is analyzed for all aspects. Table 4 informs the result of item validity by using Aiken index.

TABLE 4
THE CONVERSION OF SCORE EVALUATION OF CONCEPT COMPREHENSION TEST INSTRUMENT BY USING AIKEN INDEX

No.	Aspect	Average	$V = \sum s/n (c-1)$	The coefficient score average of Aiken
1	Materials	4.00	1.00	0.94
		3.75	0.92	
		3.75	0.92	
		3.75	0.92	
2	Construction	3.25	0.75	0.85
		3.50	0.83	
		3.75	0.92	
		3.75	0.92	
		3.50	0.83	
3	Language	3.75	0.92	0.90
		3.75	0.92	
		4.00	1.00	
		3.25	0.75	
		3.75	0.92	
	Total	51.5	12.5	12.50
	Average	3.68	0.89	0.89

Based on Table 4, this can be categorized as the validity of the item based on the Aiken criterion (see Table 2). In all aspects, both material (0.94), construction (0.85), and language (0.90) have indexes above 0.35. These results show that all aspects of this item in category strongly essential. Before students did the multiple-choice as the post-test, they involve in the blended learning activities. Some of the screenshot of the activities during online in EDMODO are shown in Fig. 2 to Fig. 3.

Fig. 2*. The discussion about the assignment between the student (Rizka N Amelia) and the teacher.*

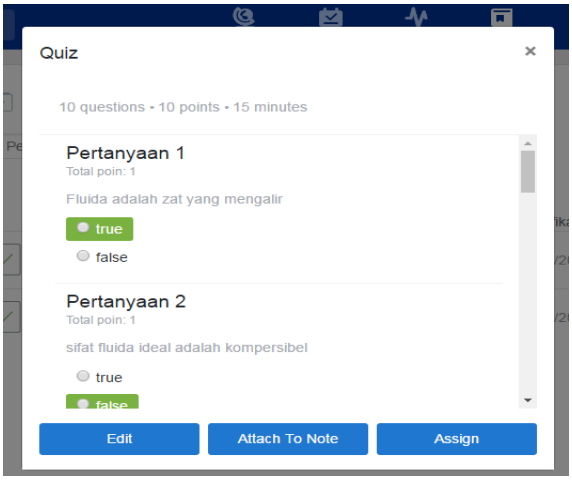

Fig. 3*. The example of the quiz for learning apperception before the main activity.*

The effect of the learning activity based on the proposed strategy was represented by the understanding of increment or the gain. Table 5 informs that the increase of concept comprehension is viewed from the difference of N_{gain} between pretest and posttest score of experimental and control classes. Student of the two groups did the pretest before the treatment (blended learning), and posttest after the treatment.

TABLE 5
GAIN OF EXPERIMENTAL AND CONTROL CLASSES

Group	Number of students	N_{gain}	Classification
Control	32	0.58	Medium
Experimental	32	0.65	Medium

Table 5 shows that N_{gain} score of 0.65 of the experimental group and 0.58 of the control group are categorized medium. It means that both groups are in the same category. It is an exciting finding that should be explored. The normality test is conducted to find out whether each sample comes from a normal distribution of population or not. The normality test in this research used the One-Sample Kolmogorov-Smirnov test on the SPSS 16.0 with a significance level of 0.05, as shown in table 6.

TABLE 6
THE NORMALITY TEST OF THE VARIABLES

Variables	Experimental class	Control class	Concl.

	Sig.	Sig.	
Pretest	*0.071*	*0.088*	*Normal*
Posttest	*0.200*	*0.200*	*Normal*
Verbal ability	*0.200*	*0.200*	*Normal*
Numerical ability	*0.200*	*0.088*	*Normal*

Table 6 informs that the understanding score in both experimental and control groups have a normal distribution (p-value> 0.05).

Besides the normal distribution, we checked the homogeneity test too to find out whether variants of the two populations are homogenous or not. Table 7 shows the result of the homogeneity test.

TABLE 7
THE HOMOGENEITY TEST OF THE VARIABLES

Variables	*Sig.*	*Alpha*	*Concl.*
Pretest	*0.469*	*0.05*	*Homogen*
Posttest	*0.367*		*Homogenous*
Verbal ability	*0.584*		*Homogenous*
Numerical ability	*0.129*		*Homogenous*

Table 7 informs that data of both experimental and control classes is homogeneous (p-value> 0.05). T-test analysis is to find out the significant difference of posttest result of concept comprehension between the experimental and control classes — t-test analysis using SPSS 16.0. Table 8 shows the result of the T-test. Table 8 informs that based on the result of t-test analysis, t-score is 3.11 with p-value=0.003 (lower than 0.05), so there is a significant difference in the result of the concept comprehension test between the experimental and control classes.

TABLE 8
T-TEST ANALYSIS

Class	*N*	*Average score*	$t_{calculation}$	*df*	*Sig. (2-tailed)*
Experimental	*32*	*82.25*	*3.11*	*62.00*	*0.003*
Control	*32*	*75.53*	*3.11*	*61.01*	*0.003*

The ANCOVA test used a three-variable covariant analysis technique using SPSS 16.0 and Microsoft Excel. Table 9 shows the result of the covariant analysis.

TABLE 9
THE RESULT OF ANCOVA

Number of variation	*db*	*JKR*	*MK*	F_{count}	$F_{t5\%}$
Between (A)	*1*	*346.792*	*346.792*	*5.509*	*4.00*
Within (d)	*60*	*3776.715*	*62.945*		
Total (T)	*61*	*4123.507*			

In this research, there are two types of contributions, which are useful and relative contribution. Table 10 shows the summary of the score of relative and effective contributions of each independent variable towards the dependent variable.

TABLE 9
THE SUMMARY OF RELATIVE AND EFFECTIVE CONTRIBUTIONS OF COVARIATES

Covariate	Relative contribution (%)	Effective contribution (%)
Prior knowledge	2.42	1.48
Verbal ability	11.84	7.22
Numerical ability	85.74	52.30
Total	100	61

3.2 DISCUSSION

This research aims to implement blended learning based on guided inquiry to enhance the understanding of the physics concept in terms of prior knowledge, verbal ability, and numerical ability.The test questions of the concept comprehension were validated with content validity by using Aiken index. The result is 0.89 with interpretation category of strongly essential. The increase of concept understanding was viewed from N_{gain} test of pretest and posttest score of the students. From the result of the analysis, N_{gain} of the experimental class, which is 0.65, is higher than the control class, which is 0.58. The increase of the concept comprehension of the experimental and control classes are in the medium category. It might be because the learning activities of inquiry-based learning becomes visible when quality measures of the learning process of learning by inquiry (e.g., by utilizing CVS hands-on skills) are investigated [19]. In summary, students were able to show that learning of science content through inquiry learning is indeed possible, as students not only constructed new knowledge through engagement with inquiry tasks but they did so by using scientific reasoning skills [20]. From the analysis result on the difference of the concept comprehension viewed from the posttest score of the experimental and control classes, there is a difference in the average score between the two classes. The average score of the experimental class is 82.25, which is higher than the score of the control class, that is 75.53. Beside viewed from the difference in the average score between the two classes, t-test was also conducted to compare the posttest score of the two classes. From the analysis, it appears that significant coefficient of 0.003 is less than the significance level (α) of 0.05, so there is a significant difference of the test result of the concept comprehension between the experimental and control classes. In other words, the learning on static fluid materials based on guided inquiry model by using EDMODO (blended learning) is better in enhancing the concept comprehension of the students than the conventional method of lecture. The result of the ANCOVA test also shows that there is an influence of different treatments towards the concept comprehension of the students in terms of prior knowledge, verbal ability, and numerical ability. Both experimental and control classes are on the normal distribution for the result of pretest, posttest, verbal ability, and numerical ability. The finding proves that on the result of precondition test analysis stating that if significance score > 0.05, so it is a normal distribution of data. Besides, both classes are homogenous. The result of the research shows that there is a relationship between prior knowledge, verbal ability, and numerical ability towards learning with the dependent variable,

which is the comprehension of the static fluid concept with $F_{calculation}$ of 5.509 and F_{table} of 4.00 for a significance level of 0.05. $F_{calculation} > F_{t5\%}$, so it means that there is an influence on the concept comprehension in terms of prior knowledge, verbal ability, and numerical ability. The result of regression coefficient using SPSS 16.0 is $R^2_{y(1,2,3)}$ = 0,610, which means 61% from the concept comprehension result used, beside the prior knowledge, verbal ability, and numerical ability, other variables also influence this research. $F_{reg\ calculation}$ = 14.51 compared to F_{table} of 3.99 on the significance level of 5%, $F_{reg\ calculation} > F_{t5\%}$, therefore the regression coefficient (independent variables/ covariates) is significant. The three covariates which are prior knowledge, verbal ability and numerical ability give the effective contribution of 61% towards the concept comprehension which means 61% of the concept comprehension of the students could be explained through prior knowledge, verbal ability, and numerical ability. Thus, in other words, other factors explain 39% of the concept of comprehension. Separately, the effective contribution of the prior knowledge is 1.48%, verbal ability is 7.22%, and numerical ability is 52.30%. Based on the ANCOVA test, significance score of the three covariates are less than the significance level of 0.05, so it means the different treatment to prior knowledge, verbal ability, and numerical ability influences the concept comprehension of the students. From the result of effective and relative contribution in table 10, it appears that numerical ability contributes higher than other covariates because the concept of static fluid needs ability related to numeric, to use or manipulate numeric relation, to elaborate logically and not only imagine but it needs a learning media that can give visualization of the concept. In addition to numerical ability, verbal ability is also necessary for static fluid learning because, in the materials, there are many symbols, so to understand the materials students need to master verbal ability. Verbal skills are crucialfor the development of scientific reasoning skills because of the need to encode and store information in memory via the verbal route [20]. To achieve excellent learning outcomes or achievement, students should have the good verbal and numerical ability that would influence the excellent achievement of the concept comprehension [21, 22]. As the results of research in the utilization of information and communication technology in learning both in the fields of science and non-science, this study shows a similar trend. There is a positive impact of learning with this strategy, not only on understanding concepts but also on other aspects. Several factors influence this impact that also occurred in this study. Students who tend to be comfortable in online activities become more motivated in online learning (including blended learning). The relatively high level of interaction during online (posting, forums, quizzes) is an indicator of students' convenience in online learning. Knowledge sharing during online is carried out in classroom learning when face-to-face activities. The guided inquiry model in the classroom makes students higher in controlling individual learning, which strengthens understanding during online activities. These activities need to be considered to be able to achieve the learning objectives optimally. Low interaction because the teacher is less intense in developing the learning environment can be a cause for the decline in student motivation. Social presence during online is significant besides academic presence in online learning.

4 CONCLUSION

The physics learning on static fluid materials through blended learning based on guided inquiry could enhance the concept comprehension in terms of the prior knowledge, verbal ability, and numerical ability of the students. It means that by the difference of the scoring average of posttest between experimental and control classes with the significant gain enhancement. In other words, there is an influence on the increase of the concept comprehension of the students learning based on a guided inquiry by using EDMODO and the conventional learning in terms of the prior knowledge, verbal ability, and numerical ability. The three covariates which are prior knowledge, verbal ability, and numerical ability give the effective contribution.

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