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THE INFLUENCE OF BLENDED LEARNING-BASED GUIDED INQUIRY LEARNING MODEL AND SELF EFFICACY ON STUDENTS' SCIENTIFIC LITERACY

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Abstract:
This quasi-experimental study is devoted to determining the influence of Blended Learning-based Guided Inquiry learning model and Self-Efficacy on students' scientific literacy. To achieve this goal, this study involved 148 students at Grade X of Senior High School SMA Wirabakti as the population by employing a Treatment by Level 2 x 2 design. The sample, on the other hand, went through the Multi-Stage Random Sampling technique, i.e., sample randomly taken from the population without considering any levels. Further, this study also relied on several data sources, including (1) the data of students' scientific literacy skill collected from a multiple-choice test with five options; (2) the data of self-efficacy collected from a questionnaire with five items of always (score 5), often (score 4), sometimes (score 3), rarely (score 2), and never (score 1). The collected data were then analyzed using the two-way analysis of variance (ANOVA 2x2). The results reveal that the Blended Learning-based Guided Inquiry learning model and Self-Efficacy do significantly influence students' scientific literacy, by which this model serves as one of the proper learning models applied in the learning process that can improve scientific literacy.

Keywords: guided inquiry, blended learning, self-efficacy, scientific literacy

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1. Introduction

Scientific literacy, as defined by PISA, is the capacity to apply scientific knowledge, to recognize questions, and to draw evidence-based conclusions as an effort to understand, support, and produce considerations on the natural world as well as various transitions performed through human activities. This definition views scientific literacy as a multidimensional thing that does not only concern the understanding of science (OECD, 2013, 2000, 2004).

Science educators play an indispensable role to teach and train students to develop their scientific literacy skill. Science education is expected to provide effective ways for students to improve: (a) knowledge and investigation of natural science; (b) oral and written vocabulary required in mastering and conveying science; (c) relationship between science, technology, and society (Hernandez, et al., 2015: 26). One of the important goals of science education is to develop scientific literacy, given that scientific literacy belongs in the key components of science education that intends to prepare students to be able to think along with functioning to have accountability as world citizens who are increasingly influenced by science and technology.

Nevertheless, a proven fact shows that students' scientific literacy falls under a low category. A preliminary direct interview with 15 students of Grade X majoring in natural sciences of senior high school SMA Terpadu Wira Bhakti and SMAN 1 Kabila, regarding science and technology issues, revealed that the students could only utilize and write scientific terms in natural sciences, yet they could not justify those terms. They also understood interdisciplinary concepts, yet unable to explain the linkages among them. This indicates that students' scientific literacy skill is far from being good, in the light of the fact that most of them have not reached the conceptual level of literacy, i.e., students use interdisciplinary concepts and show comprehension and the linkages among those concepts with a general comprehension of science. Such initial finding is also supported by a study conducted by (Odja, A. Haris, and Citron S. Payu 2014: 1).

The success of the classroom learning process can be seen from students' learning activities and outcomes. The lack of scientific literacy, as described earlier, is influenced by some factors; one of which is mistakes during the learning process as a result of inappropriate learning model or teachers' habit to implement conventional science learning model that does not pay good attention to the significance of scientific literacy as the must-have competence for students (Norris & Pillips, 2003: 225-226). This certainly will affect the achievement of students' scientific literacy.

On that ground, applying science learning model that emphasizes on inquiry, experiment, and problem-solving skills is required (Gucluer and Kesercliogl u, 2012: 8; Adolphus, 2012: 445), or called as the inquiry-based science learning model.

For some time now, there have been many educators employ inquiry as one of the science learning models to enhance scientific literacy (Gormally and Brickman, P. et al. 2009 : 3; Seraphin et al. 2012: 368). Similarly, Odegaard and Haug Berit, et al. 2015: 274; Ogan-Bekiroglu, Arslan, 2013: 1187 argue that inquiry-based integration in sciences and literacy activities give an increased learning outcome. Inquiry is a learning model that involves students in scientific works as if they were real scientists (Banerjee, 2010: 2; Tan and Kim, 2012 : 11), which also gives them an opportunity to use scientific reasoning and critical thinking to explore the understanding of science (Banerjee, 2010 : 2) and problem-solving skill (Trna et al., 2012 : 201).

Guided Inquiry learning model utilizes science process skills; so that students discover phenomena, build concepts, theories, and scientific attitudes of themselves. It will lead to positive effects on the quality of educational processes or products. The skills include making hypotheses in the process of inquiring or discovering problems. Stages of Guided Inquiry are in line with domain framework for scientific literacy competencies that elaborate scientific phenomena, evaluate and design scientific studies, and interpret scientific data and evidence (OECD, 2013).

In the process of Guided Inquiry learning, teacher and students need more time and communication in which this is the shortcoming of such learning (Eggen, & Kauchak, 2012: 211). Besides, inquiry learning requires a large number of learning sources (Ogan and Feral-Bekiroglu et al. 2014: 1188). One of the alternatives to address this time limit, however, is by using technology and information in the science learning process, which is known as Blended Learning.

Blended Learning is clarified as learning that combines online learning with face-to-face teaching and learning methods (Hubackova & Ilona Semradova, 2016: 552; Chaiyama, 2015: 483; Vaughan, 2014: 248). It is able to facilitate independent and collaborative learning experiences that build inquiry community and platform to a free and interactive dialogue (Okaz, 2015: 552). Special supports offered by Blended Learning to help out inquiry learning are fast and flexible access to information, learning sources, and materials (Wright, 2010: 236), exposing a variety of learning sources, and leading to accessible outside world which provides opportunities for students to pursue intriguing and relevant questions (Wallace et al. 2000: 78). The integration between Guided Inquiry and Blended Learning can prompt a meaningful, effective, and efficient learning process that is impactful on the enhancement of scientific literacy.

Self-efficacy in the science learning process should also be taken into account in encouraging the accomplishment of scientific literacy, considering that the affective domain (attitudes) of science encompasses supporting scientific inquiry, confidence, interest in science, and responsibility for resources and environment. (PISA, 2006, PISA, 2015).

Self-efficacy can influence the success of the learning process and students' academic achievement. Zimmerman (2000:82) points out that self-efficacy bolster the students to optimize their ability. This is strengthened by (Liu, et al. 2006: 227; Tuan, et al. 2005: 642) that self-efficacy can bolster students' motivation in the learning process in order that they feel confident to work on difficult and easy assignments. No less a scholar than Bandura (1997:194) states that in daily learning activities, students with high self-efficacy are way more convenient to participate in the learning process, have a strong effort, courageous, and able to control their emotional reactions in facing learning obstacles. Students with low self-efficacy, in contrast, doubt their ability, feel incapable, undetermined, discouraged, sluggish, and easily stressful once they are given hard tasks (Bandura, 1997: 72).

Self-efficacy in the application of Blended Learning-based Guided Inquiry learning model is expected to influence students' scientific literacy, by which students will work on their tasks with initiatives, so that they will be responsible for the tasks and do it as good as possible.

Based on the above description, this study is primarily concerned with the influence of Blended Learning-based Guided Inquiry learning model and Self Efficacy on scientific literacy.

2. Methodology

This quasi-experimental study employed the Treatment by Level 2 x 2 design and involved 148 students at Grade X of Senior High School SMA Wirabakti as the population. The sample, on the other hand, went through the Multi-Stage Random Sampling technique, consisting of two classes taught by Blended Learning-based Guided Inquiry model and two classes taught by Direct Instruction model. From those four classes, there were 27% of the upper group and 27% of the lower group to measure the level of students' self-efficacy. This study was conducted from January to March 2019 in the second semester of the academic year 2018/2019.

The study relied on several data sources, including (1) the data of students' scientific literacy skill collected from a multiple-choice test with five options; (2) the data of self-efficacy collected from a questionnaire with five items of always (score 5), often (score 4), sometimes (score 3), rarely (score 2), and never (score 1).

Prior to the field trial to examine the items validity and instruments reliability, the instruments were first consulted with the promoter and co-promoter, and expert validity. For scientific literacy test, the measurement of items validity used the correlation formula of *point biserial*. The analysis result with the significance level 0.05 (r_{table} 0.355) showed that out of 36 items, 29 items were valid and seven items were invalid (drop). Moreover, the measurement of instrument reliability utilized the KR-20 formula. The result revealed that the r_{11} of scientific literacy test arrived at 0.871, implying that the reliability of this test achieved a high level. The self-efficacy instrument was to measure the validity of the items employing the correlation formula of *product-moment* from Pearson; meanwhile, the measurement of the instrument reliability utilized the *Alpha Cronbach* formula. The analysis result with the significance level 0.05 (r_{table} 0.355) indicated that out of 40 items, 32 items were valid and eight items were invalid (drop). The result brought out the fact that the r_{11} of self-efficacy instrument arrived at 0.889, meaning that the reliability of this test reached a high level.
Data analysis to test the hypotheses applied both descriptive and inferential analyses; descriptive analysis at times determined the mean, median, modus, and standard deviation, and at other times visualized research findings in the form of frequency distribution table and histogram; inferential analysis was related to hypotheses testing.

Further, the used statistical test was the two-way analysis of variance (ANOVA 2x2) for the hypotheses that included in the "main effect" and "interaction effect" groups in the significance level α = 0.05. Hypotheses included in the "simple effect" group employed the *Tuckey* further test in the significance level α = 0.05. Before testing the hypotheses, this study carried out data normality testing utilizing the Liliefors test and variance homogeneity using the Bartlett test for four data groups with the acceptance criterion (accepted), and were rejected in other alternatives. Those four groups were homogenous (□□$_{count}$□ □□$_{table}$).

3. Results

The description of research data is in the form of the mean (M), median (Me), modus (Mo), standard deviation (SD) and is presented in a frequency distribution table. The following table provides the data description of scientific literacy of all groups.

Table 1: Data Description of Students' Scientific Literacy Skill

Group	Minimum Score	Maximum Score	Range	Mean	Me	Mo	SD
A_1	52	85	33	68,00	67,50	56	10,59
A_2	50	78	28	65,72	68,00	68	8,86
B_1	68	85	17	75,31	75,50	70	4,58
B_2	50	68	18	58,41	58,00	56	4,99
A_1B_1	70	85	15	77,63	78,00	76	4,38
A_2B_1	68	78	10	73	73,50	77	3,58
A_1B_2	52	65	13	58,38	58,50	56	3,89
A_2B_2	50	68	18	58,44	57,00	52	6,03

Description:
A1 = Score of students' scientific literacy taught by Blended Learning-based Guided Inquiry learning model
A2 = Score of students' scientific literacy taught by Direct Instruction model
B_1 = Score of students' scientific literacy with high self-efficacy
B_2 = Score of students' scientific literacy with low self-efficacy
(A_1B_1) = Score of students' scientific literacy taught by Blended Learning-based Guided Inquiry learning model with high self-efficacy
(A_2B_1) = Score of students' scientific literacy taught by Direct Instruction model with high self-efficacy
(A_1B_2) = Score of students' scientific literacy taught by Blended Learning-based Guided Inquiry learning model with low self-efficacy
(A_2B_2) = Score of students' scientific literacy taught by Direct Instruction model with low self-efficacy

3.2 Analysis Requirement Test

Data normality testing was performed by the *Liliefors* test with the significance level α = 0.05. The testing criterion was rejecting the null hypothesis stating that the population would be normally distributed if the value of *Sig*. was less than 0.05, and the null hypothesis was accepted in other alternatives. The calculation result is shown in Table 2 below.

Table 2: Results of Data Normality Testing of Scientific Literacy Skill of All Groups

Group	Kolmogorov-Smirnov[a]			Conclusion
	Statistics	**df**	**Sig.**	
A_1	.110	16	.200*	Normal
A_2	.104	16	.200*	Normal
B1	.205	16	.200*	Normal
B_2	.110	16	.200*	Normal
A_1B_1	.141	16	.200*	Normal
A_1B_2	.110	16	.200*	Normal
A_2B_1	.205	16	.200*	Normal
A_2B_2	.104	16	.200*	Normal

The above table signifies that the value of *Sig* of the eight groups is more than the value of α = 0.05, or in other words, **H_0 is accepted.** Accordingly, the sample of those eight groups comes from a **normally distributed** population.

3.3 Data Homogeneity Testing

a). Variance Homogeneity Test of Treatment Groups A_1 and A_2

Homogeneity testing was carried out through the F test. The calculation result of homogeneity is presented, as follows.

Table 3: Summary of Homogeneity Test Results of Score Variance of Scientific Literacy Skill of Treatment Groups A_1 and A_2

		Levene's Test for Equality of Variances	
		F	Sig.
Scientific Literacy Skill	Equal variances assumed	3.803	.056
	Equal variances not assumed		

Table 3 reveals that the value of *Sig. Lavene's Test for Equality of Variances* for the result of students' scientific literacy skill gets 0.056; thus, 0.056 > 0.05, summing up that the variance between the tested two groups is **homogeneous**.

b). Variance Homogeneity Test of Attribute Groups B_1 and B_2

The following table 4 presents the homogeneity calculation result.

Table 4: Summary of Homogeneity Test Results of Score Variance of Scientific Literacy Skill of Attribute Groups B_1 and B_2

		Levene's Test for Equality of Variances	
		F	Sig.
Scientific Literacy Skill	Equal variances assumed	0.473	.494
	Equal variances not assumed		

It is indicated that the value of *Sig. Lavene's Test for Equality of Variances* for the result of students' scientific literacy skill arrives at 0.494; hence, 0.494 > 0.05, meaning that that the variance between the tested two groups is **homogeneous**.

c). Variance Homogeneity Test among Cell Groups in Experimental Design (between A_1B_1, A_2B_1, A_1B_2, and A_2B_2)

Variance homogeneity testing of those four groups employed the Bartlett test in which the homogeneity calculation result is given below.

Table 5: Summary of Homogeneity Test Results of Score Variance of Scientific Literacy Skill

Box's M		**5.086**
F	Approx.	1.650
	df1	3
	df2	6480.000
	Sig.	.176

The value of Box's M for the result of students' scientific literacy skill reaches 5.086. Since 5.086 > 0.05, **H_0 is accepted**, signifying that there is no variance difference among the tested four groups. Therefore, the data of those groups are **homogenous**.

3.4 Hypotheses Testing Results

Hypotheses testing used the two-way variance analysis (ANOVA 2 x 2), and the result is provided in the following Table 6.

Table 6: Summary of ANOVA Calculation Results of Scientific Literacy Skill

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4719.922a	3	1573.307	75.689	.000
Intercept	285823.891	1	285823.891	13750.485	.000
Learning Model	87.891	1	87.891	4.228	.044
Self-Efficacy	4539.391	1	4539.391	218.382	.000
Learning Model * Self-Efficacy	92.641	1	92.641	4.457	.039
Error	1247.188	60	20.786		
Total	291791.000	64			
Corrected Total	5967.109	63			

a. R Squared = .791 (Adjusted R Squared = .781)

3.4.1 The First Hypothesis Testing

The result of variance analysis among A (learning model) gets the F_{count} = 4.228 that is more than F_{table} = 4.00 with the value of *sig* 0.044. In the significance level α = 0.05, the value of *sig* is 0.044 < 0.05, implying that the null hypothesis "there is no scientific literacy difference between students taught by Blended Learning-based Guided Inquiry model and those taught by Direct Instruction model" **is rejected**. For this reason, the first hypothesis "students taught by Blended Learning-based Guided Inquiry model get higher scientific literacy than those taught by Direct Instruction model" **is accepted**.

3.4.2 The Second Hypothesis Testing

The result of variance analysis among B (self-efficacy) gives the value of F_{count} = 218.382 that is more than F_{table} = 4.00 with the value of *sig* 0.000. In the significance level $\alpha = 0.05$, the value of *sig* is 0.000 < 0.05, or in other words, the null hypothesis "there is no scientific literacy difference between students with high self-efficacy and those with low self-efficacy" **is rejected**. Hence, the second hypothesis "students with high self-efficacy reach higher scientific literacy than those with low self-efficacy" **is accepted**.

3.4.3 The Third Hypothesis Testing

The result of variance analysis between A and B (learning model x self-efficacy) shows the value of F_{count} = 4.457 that is more than F_{table} = 4.00 with the value of *sig* 0.000. In the significance level $\alpha = 0.05$, the value of *sig* is 0.039 < 0.05, meaning that the null hypothesis "there is no interaction between learning model and self-efficacy towards students' scientific literacy" **is rejected**.

Based on the result of ANOVA testing on the significant interaction between learning model and self-efficacy towards students' scientific literacy, the further *Tuckey* test was done to prove the influence difference between both variables towards students' scientific literacy.

The calculation result of Tuckey test for both groups/subjects that are compared is given below.

Table 7: Summary of Tuckey Test Calculation Results ($\alpha = 0.05$)

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.
A1B1	A2B1	4.63*	1.616	.029
	A1B2	19.25*	1.616	.000
	A2B2	19.19*	1.616	.000
A2B1	A1B1	-4.63*	1.616	.029
	A1B2	14.63*	1.616	.000
	A2B2	14.56*	1.616	.000
A1B2	A1B1	-19.25*	1.616	.000
	A2B1	-14.63*	1.616	.000
	A2B2	-.06	1.616	1.000
A2B2	A1B1	-19.19*	1.616	.000
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.
	A2B1	-14.56*	1.616	.000
	A1B2	.06	1.616	1.000

3.4.4 The Fourth Hypothesis Testing

The analysis result of Tuckey test for students (group A_1B_1) with high self-efficacy indicates that the Blended Learning-based Guided Inquiry model does significantly influence students' scientific literacy skill, compared to the Direct Instruction model

(A_2B_1). This is evidenced by the value of Mean Difference *(I-J)* getting 4.63 and significance of 0.029 < 0.05.

3.4.5 The Fifth Hypothesis Testing

The analysis result of *Tuckey* test for students (group A_1B_2) with low self-efficacy signifies that the Direct Instruction model (A_2B_2) insignificantly influences students' scientific literacy skill, compared to the Blended Learning-based Guided Inquiry model. This is proven by the value of Mean Difference *(I-J)* getting -0.6 and significance of 1.000 < 0.05.

4. Discussion

4.1 First Hypothesis

The analysis result reveals that there is a difference in the scientific literacy of students taught by the Blended Learning-based Guided Inquiry model and Direct Instruction model. This result is in line with the calculation of descriptive test showing that students' average scientific literacy skill taught by the Blended Learning-based Guided Inquiry model ($\bar{X}$ = 68.00; SD = 10.59) arrives at a higher value than the average scientific literacy skill of students taught by the Direct Instruction model ($\bar{X}$ = 65.72; SD = 8.86).

The finding signifies that the application of Blended Learning-based Guided Inquiry model provides a better effect on scientific literacy skill than Direct Instruction model does. It also verifies that employing Blended Learning-based Guided Inquiry model is way more effective compared to the implementation of the Direct Instruction model. Wenning (2011), Bilgin (2009), Kuhlthau (2010), besides, claim that Blended Learning-based Guided Inquiry model is more potent than Direct Instruction model in improving the process of learning science.

In short, the result of this study is consistent and following several previous studies in addition to giving a contribution to the result that indicates a significant difference in the scientific literacy of students taught by Blended Learning-based Guided Inquiry model and Direct Instruction model.

4.2 Second Hypothesis

The analysis result brings out the fact that there comes an interaction between learning model and self-efficacy towards scientific literacy skill. In applying the Blended Learning-based Guided Inquiry model, students' interaction is improved through Google Classroom (website, online chatting, and e-mail), being independent and confident in learning through independent learning facilities (interactive media/learning CD (offline), being interactive with each other, and being motivated to discipline themselves in online learning. This is in line with (Jacobsen & Kauchak, 2009), stating that Blended Learning-based Guided Inquiry model also enables the student-centered, collaborative, independent, and proactive learning along with increasing higher learning outcomes than the conventional learning process.

To sum up, the interaction between learning model and self-efficacy implies that both variables can significantly enhance scientific literacy skill. This is to say that Blended Learning-based Guided inquiry model is more suitable to apply to students with high self-efficacy; students with low self-efficacy are more appropriately taught by Direct Instruction model.

4.3 Third Hypothesis

The analysis result reveals that learning model significantly interacts with self-efficacy by which such interaction contributes to scientific literacy skill. Students' self-efficacy in implementing the Blended Learning-based Guided Inquiry model, i.e., giving questions or problems, making hypotheses, designing experiments, conducting experiments to obtain data, collecting and analyzing data, and drawing conclusions, is crucial and influential on scientific literacy skill. This is due to the fact that students with high self-efficacy have greater endurance and more significant achievement in learning science and engineering than those with low self-efficacy (Lent, et al. 1986). Students with high self-efficacy consider that difficult assignments are challenges to master, not to avoid.

The above theory is in compliance with the result of this study, in which the data analysis result and the third hypothesis testing indicate that students with high self-efficacy and taught by Blended Learning-based Guided Inquiry model reach higher scientific literacy than those taught by Direct Instruction model.

4.4 Fourth Hypothesis

Students with low self-efficacy and taught by the Direct Instruction model arrives at similar scientific literacy (average score 58.44) to those taught by Blended Learning-based Guided Inquiry model (average score 58.38). On that ground, Direct Instruction model is able to improve scientific literacy skill of students with low self-efficacy; this finding is supported by Santrock (2010: 472) that Direct Instruction is a structured teacher-centered approach characterized by teacher's instruction and control, teacher's high expectation on students' progress, time spent by students on academic assignments, and teacher's effort to minimize negative effects on students, that in turn is strongly related to students' achievement.

5. Conclusion

This study comes to the conclusion that Blended Learning-based Guided Inquiry learning model serves as one of the proper learning models applied in the learning process that can improve the scientific literacy of students with high self-efficacy. For students with low self-efficacy, on the other hand, Direct Instruction model is one of the appropriate learning models implemented in the learning process to enhance their scientific literacy.

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