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The Effectiveness of Guided Discovery in Distance Learning to Improve Scientific Literacy Competencies of Primary School Students

Agustin Anggriani[1]✉ , Sarwi Sarwi[2], Masturi Masturi[2]

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[1.] MI Al Khoiriyyah 01 Semarang, Indonesia
[2.] Pascasarjana, Universitas Negeri Semarang, Indonesia

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Abstract

This study aims is to determine the effectiveness of the guided discovery model in distance learning to improve students' scientific literacy competencies. The method used in this study was an experimental method with a pretest-posttest one group design. The research subjects were fifth grade students from three schools — Primary School A, Primary School B, and Primary School C — in Kudus Regency, Central Java, Indonesia. Sampling was determined using purposive sampling technique. Data collection techniques used scientific literacy tests. The data analyses used were paired sample t-test, one-way ANOVA test and n-gain test. The results of the paired sample t-test showed that there were significant differences in the mean scores of scientific literacy competences before and after the guided discovery model was applied. The one-way ANOVA test showed that there was a significant difference in the mean score between the three primary schools studied. Students at Primary School B, located in suburban area, scored the highest on average in scientific literacy competencies, followed by Primary School C students in urban area and Primary School A students in remote area. Based on the n-gain test, two primary school has high criteria with score 0.74 and 0.73 for school B and C, respectively. And the other one has moderate criteria for School A with n-gain score is 0.59. That means, guided discovery model is effective to improve the scientific literacy competencies on primary school student in Kudus Regency, Central Java, Indonesia.

✉ Correspondence address:
Jalan Rahtawu Raya RT 02/I Menawan Gebog Kudus Jawa Tengah
Indonesia 59354E-mail: agustin.anggriani.edu@gmail.com

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INTRODUCTION

The learning process has now reached the 21st century where information is widespread and technology is developing rapidly (Chuntala, 2019; Sarwi et al., 2019). The main pedagogical beliefs communicated through discussions of "21st century education" revolve around "student-centered learning", "personalized learning", and "technology integration" (Gajjar, 2013). Within the well-known framework for 21st century learning, EnGauge and UNESCO, it is stated that one of the things that is essential for humans in the 21st century is scientific literacy (Chalkiadaki, 2018). This is a challenge for all nations in the world to prepare a literate generation that can adapt to the changing times.

One of the efforts of the Indonesian government in preparing the next generation to be able to compete in the 21st century as well as adapting to changes and developments in science and technology is through education (Nisa et al., 2019). For this reason, the 2013 Curriculum or K-13 Curriculum was created for the level of education starting from Primary School to Senior High School. The expected goal of the 2013 Curriculum is to develop students' character, competency and literacy, one of which is scientific literacy (Ardiyanti et al., 2019). Thus, through the implementation of the 2013 Curriculum, Indonesian students are expected to be more scientifically literate.

Nowadays, scientific literacy is a demand that must be mastered by every individual, both in everyday life and in the world of work (Yaumi et al., 2017). Therefore, Indonesia always participates in the Program for International Student Assessment (PISA) to measure the achievement of scientific literacy. Scientific literacy in the 2018 PISA contains three indicators in the real~~m~~ of competencies. This includes explaining phenomena scientifically, evaluating and designing scientific enquiry, and interpreting data and evidence scientifically. Although Indonesia always participates in PISA consistently, the scientific literacy of Indonesian students always lies below the global average score of scientific literacy (Seprianto, 2020). As reported in the 2018 PISA study, the achievement of Indonesian students on scientific literacy was only ranked 70 out of 78 participating countries with an average score of 396. It may be noted that this achievement decreased from the 2015 results which were ranked 62 out of 70 participating countries with an average score of 403. It indicates that the scientific literacy of Indonesian students is still not as expected.

Scientific literacy can be trained in student learning activities (Yuniar et al., 2020). In the 2013 Curriculum, this part is mostly contained in the science learning. Science is knowledge that is obtained through learning and verification. However, in the process of learning science in primary schools, various problems were found (Atmaji & Maryani, 2018). A particular problem that occurs in science learning is that students are not encouraged to find and construct their own knowledge, but they are more required to memorize material provided by the teacher (Martaida et al., 2017). The low scientific literacy of Indonesian students is supported by the initial scientific literacy test result of Grade V students of the 2019/2020 school year in three primary schools in Kudus Regency, Central Java, Indonesia. From 98 students as research participants, the average score of students' scientific literacy is still below the Minimum Mastery Criterion (KKM) of Science set by the schools — 75. This is evidenced by the percentage of classical completeness of each primary school which only reached 16.67%, 14.28% and 19.57% respectively. Further, conforming to the results of observation and interview, it was found that science learning in the classroom was still teacher-centered. Moreover, experimental activities were rarely conducted.

Science learning should teach how the knowledge is found by the students themselves (Puspitasari et al., 2018). The teacher as a facilitator must also apply a learning model that is in accordance with the learning objectives and attracts students' interest so that students understand the essence of the material presented (Hamidah & Haryani, 2018). Therefore, it is

necessary to apply a student-centered learning model that makes students are able to construct their own knowledge so that students' scientific literacy improves. This can be achieved through applying the guided discovery learning model. The guided discovery model can determine the level of scientific literacy skills since this learning model contains stages which are the basis for achieving aspects of scientific literacy competencies (Merta et al., 2020). The teacher acts as a facilitator who states problems as well as guiding students to solve the problems according to the teacher's instructions provided in the worksheet.

March 2, 2020 was the first day of COVID-19 case reported in Indonesia. The Coronavirus (SARS-CoV-2) which is the cause of this case is spreading rapidly in Indonesia and also the entire world. This report has changed various sectors to comply with health protocols, including in the field of education (Pamungkas & Sukarman, 2020). Minister of Education and Culture issued Circular Letter Number 4 of 2020 on Implementation of Education Policies in an Emergency Period for the Spread of Coronavirus Disease (COVID-19) which stated that learning activities in Indonesia are required to use distance learning. In this distance learning, the guided discovery stages must still exist even though the platform uses e-learning.

Previously, there was no guided discovery research in distance learning to improve students' scientific literacy competencies. Therefore, this study aims to determine the effectiveness of the guided discovery model in distance learning to improve the scientific literacy competencies of primary school students.

METHOD

The method used in this research was an experimental method with a pretest-posttest one group design. The populations in this study were all students of Grade V in public primary schools in Kudus Regency, Central Java, Indonesia, while the sample was determined 98 students of Grade V from Primary School A, Primary School B and Primary School C. The three primary schools are located in three different districts with different type of locations. Primary School A is located in Gebog District which is a remote area. Primary School B is in Dawe District, which is a suburban area. While Primary School C is in Bae District which is located in an urban area. Sampling was determined using purposive sampling technique.

The data collection technique was used scientific literacy test, which given before and after treatment i.e pretest and postest. Then for data analysis was used normality and homogeneity test using Kolmogorov-smirnov and Lavene equation, respectively. Both tests were as a prerequisite test for paired sample t-test and one-way ANOVA. In the final stage, an n-gain test was carried out to determine the category of improvement before and after the application of the guided discovery model. The level of effectiveness of the guided discovery model in distance learning is based on the <g> value criteria in Table 1.

Table 1. Gain Factor Value Criteria (Hake, 1999)

<g>	Criteria
<g> <0.30	Low
0.30 ≤ <g> <0.70	Moderate
0.70 ≤ <g> ≤1.00	High

RESULTS AND DISCUSSION

The guided discovery model used in this study is a guided discovery model adapted to emergency learning situations in the midst of the COVID-19 pandemic. The guided discovery model is applied by means of students being taught in WhatsApp Group platform with the Sway Office media. The use of appropriate learning media can make it easier for teachers to deliver material so that it is easily accepted and understood by students (Yahya et al., 2017). Therefore, the use of WhatsApp Group and Sway Office media is suitable for teaching students in distance learning. In the Sway Office media, there was presented learning material of "Heat and Changing State of Matter" that

support students to get several problem statements to be solved. Then students are invited to solve the problem according to the stages in the guided discovery syntax, which include orientation, hypothesis generation, hypothesis testing, conclusion, and regulation with the teacher as the facilitator. In addition to the students doing experiments to solve problems, they were also asked to document the experimental process in the form of video. The video was then submitted to the teacher for receiving feedback. Several selected videos were presented in Whatspp Group virtual class.

Before applying the guided discovery model, students were given a pretest. After the application of the guided discovery model, students were given a posttest. The initial stage for parametric statistical analysis was to test the normality of the pretest and posttest scores. The results of the pretest and posttest normality test scores were obtained through the Kolmogorov-Smirnov test which is presented in Table 2.

Table 2. Results of the Pretest and Posttest Data Normality Test

Statistic Test	PS-A	PS-B	PS-C
Pretest Mean Score	60.59	63.57	64.29
Sig. (2-tailed) Pretest	0.200	0.184	0.200
Posttest Mean Score	83.93	90.41	90.19
Sig. (2-tailed) Posttest	0.200	0.093	0.135

The criteria for data normality test using SPSS are if Sig > 0.050, then the data is declared to be normally distributed. If Sig < 0.050, then the data is not normally distributed. Table 2 shows that the pretest and posttest scores have Sig > 0.050 so that they are declared to be normally distributed. The Minimum Completeness Criterion (KKM) for science set by the three primary schools is 75. Table 2 shows pretest score for the three primary schools is below the KKM while posttest score for the three primary schools has reached the KKM.

Furthermore, the homogeneity test is conducted using ANOVA in IBM SPSS Statistic 25 to see whether the data was homogeneous or not. The results of the pretest and posttest score homogeneity were obtained through the Levene test which is presented in Table 3.

Table 3. Homogeneity Test Results

Data	Statistic Test	Sig.
Pretest	Levene Test	0.314
Posttest		0.080

If Sig > 0.050, the data is declared homogeneous, whereas if Sig < 0.050, then the data is not homogeneous. From Table 3, it is known that the results of the homogeneity test with the Levene Test show Sig > 0.050, so the pretest and posttest results are homogeneous data or come from populations with the same variance.

After the data is stated to be normally distributed and homogeneous, then the paired average similarity test is used to see whether there is a significant difference before and after the application of the guided discovery model. The hypotheses in the study are as follows:

H_0: There is no significant difference before and after the application of the guided discovery model.

H_1: There is a significant difference before and after the application of the guided discovery model.

The paired average similarity test results were obtained through the paired sample t-test which is presented in Table 4.

Table 4. Paired Sample T-Test Results

Statistic Test	PS-A	PS-B	PS-C
t	-7.761	-9.004	-16.021
df	23	27	45
Sig. (2-tailed)	0.000	0.000	0.000

Based on the results of the paired sample t-test in Table 4, it was obtained Sig. (2-tailed) < 0.05, which means that H0 is rejected. In other words, H1 is accepted, that is, there is a significant difference between the pretest score

and the posttest score. This shows that there is an effect of using the guided discovery model on students' scientific literacy competencies.

Furthermore, the group average similarity test is conducted using one-way ANOVA to determine whether or not there is a difference in the average in the three experimental classes. The hypotheses in the study are as follows:

H0: There is no difference between the average science literacy scores of PS-A, PS-B and PS-C.

H1: There is a difference between the average science literacy scores of PS-A, PS-B and PS-C.

The group average similarity test results obtained through the one-way ANOVA are presented in Table 5.

Table 5. One-Way ANOVA Test Results

	df	F	Sig.
Between Group	2	5.650	0.005
Within Group	95		

Using a confidence level of 95%, α = 5%, df 1 (number of variables – 1) = 2, and df 2 (n-3) or 98-3 = 95, the results obtained for the Ftable are 3.092. H0 is accepted if Fcount ≤ Ftable. H0 is rejected if Fcount > Ftable. The value of Fcount > Ftable (5,650> 3,092), then H0 is rejected. This one-way ANOVA test shows that there is a difference in the average score between the three primary schools studied. Primary School B which is located in the suburban area has the highest score with a mean value of 90.4071, followed by Primary School C which is located in the urban area with a mean value of 90.1857 and Primary School A which is located in the remote area with a mean value of 83.9279. The mean value shows the mean score of the students' posttest science literacy scores. This show that there is a significant difference in the mean score of students' scientific literacy posttest scores between primary school students from three different type of location. The difference in the posttest mean score for each primary school was due to differences in the seriousness of students in facing scientific literacy tests. Most of Primary School B students also made more thorough preparations and actively giving questions on WhatsApp Group about things that were still difficult until they understood the explanations given by the teacher.

Furthermore, the n-gain test is conducted to determine the category of improvement before and after the application of the guided discovery model. The level of effectiveness of the guided discovery model in distance learning is based on the value criterion <g>. The results of the n-gain test are presented in Table 6.

Table 6. N-Gain Test Results

Statistic Test	PS-A	PS-B	PS-C
Pretest	60.59	63.57	64.29
Posttest	83.93	90.41	90.19
<g>	0.59	0.74	0.73
Level	Moderate	High	High

Based on the n-gain value, there are has two school including on the high criteria (PS-B and PS-C) and one school include on moderate criteria (PS-A). That means can said, the guided discovery learning is effective to improve the scientific literacy competencies of student.

Research on the success of the guided discovery model for improving scientific literacy achievement was conducted by Putri & Wasis (2016). The guided discovery model can improve students' scientific literacy achievement with moderate category. In addition, research by Khasanah et al (2016) also revealed the positive effect of the guided discovery learning model on scientific literacy. Research on the success of the guided discovery model in enhancing science learning as a bridge in empowering scientific literacy has been conducted by Herlily et al (2018). The application of the guided discovery learning model can enhance the competence of students' knowledge in science learning as seen from the percentage of classical completeness in each cycle.

Scientific literacy is an element of life skills and an overrriding provision for students to be ready to face challenges in global era (Sarwi et.al, 2020; Marantika et al., 2018). The importance of scientific literacy has been

recognized internationally as a measure of the quality level of science education (Ardianto & Rubini, 2016). It is important that students develop and master scientific literacy skills, especially in understanding scientific concepts and processes, scientific practice, and making decisions to solve problems in the surrounding environment (Sarwi et al, 2020; Monaghan-Geernaert, 2019; Engels et al, 2017; Khasanah et al, 2016). The development of scientific literacy by teachers in schools is crucial (Christensen, 2020). Even though the situation is currently in the COVID-19 pandemic, the development of students' scientific literacy competencies is an urgency that must always be considered and followed up. So far, research on the effectiveness of the guided discovery model is always conducted in direct learning. Therefore, the results of research on the effectiveness of the guided discovery model in distance learning which are proven in this study can be used as a reference for educators in improving students' scientific literacy competencies, especially in the midst of a pandemic situation through an appropriate learning model.

Choosing an appropriate learning model that can help achieve goals is an aspect that must be considered in order to teach scientific literacy effectively (Herlily et al., 2018; Toto, 2018; Yahya et al., 2017). Therefore, an appropriate learning model is required to enhance students' scientific literacy competencies, one of which is the guided discovery model. This is appropriate with the government's mandate that to improve scientific literacy competencies, it is necessary to apply research-based learning model (Haryani et al., 2019; Prasetyo & Fitri, 2018; Astra & Wahidah, 2017). The guided discovery learning model or guided discovery is a research-based constructivism learning model that allows students to construct their own knowledge based on their own activities, follow a process, observe an object, analyze, prove, draw conclusions and evaluate them (Suciarsy , 2018; Destrini et al., 2019; Astra & Wahidah, 2017; Dewi et al., 2017; Khasanah et al., 2016). The guided discovery model is a model recommended by the government that is appropriate to be applied in the 2013 Curriculum since it encourages students to be actively involved in constructing knowledge and developing science process skills which are the foundation of scientific literacy (Destrini et al., 2019; Herlily et al., 2018).

At each meeting in guided discovery implementation in distance learning, students are given direct experience to solve problem topics through independent experimental activities, yet the teacher as a facilitator still needs to provide guidance to ensure that experimental activities are conducted completely and accurately by students. The teacher as a facilitator provides guidance and instructions on experimental steps according to the guided discovery stages through the Sway Office media which is shared on the WhatsApp Group. Experiment activities involve creative thinking and open discovery but students still need instructional guidance in the form of steps in conducting practical activities (Großmann & Wilde 2019; Fransiska et al, 2018; Lestari, et al., 2018). The teacher provides instructions, suggestions, feedback, and/ or questions when learning takes place so that students do not experience difficulties and it makes learning more directed (Toto, 2018; Khasanah et al, 2016). According to Großmann & Wilde (2019), students with low initial knowledge have difficulty conducting and understanding experiments at first. This experimental activity is one of the foundations in fostering scientific literacy in students, so even students with low initial knowledge must always be supported by guidance in order to succeed in experimental activities that require direct experience. According to Sarwi et al (2019), learning that facilitates the provision of direct experience can produce knowledge that is easy to remember and durable. Thus, the experimental steps in guided discovery model in distance learning must be based on the instructions given by the teacher. In this case, students may improvise but it must be in accordance with the procedure and experimental objectives.

Science process skills cannot be separated from the goals of science education in order to foster scientific literacy (Suryanti et al., 2020).

Basic science process skills include observing, classifying, measuring, predicting, concluding, and communicating. Meanwhile, integrated science process skills include controlling variables, interpreting data, formulating hypotheses, defining variables operationally and designing experiments (Astra & Wahidah, 2017). The learning model that is suitable for practicing science process skills is the guided discovery learning model (Destrini et al., 2019). Research on the success of the guided discovery model on science process skills that can foster scientific literacy was conducted by Fransiska et al (2018). The results showed that there were differences in science process skills between students who were taught using the guided discovery learning model and students who were taught using conventional learning models. Thus, the application of learning with the guided discovery learning model has a positive impact on students' science process skills which become a bridge to foster scientific literacy competencies.

CONCLUSION

Present findings of this study confirm that the application of the guided discovery model is effective in improving students' scientific literacy competencies. This is evidenced by a significant increase in the average score of scientific literacy after the guided discovery model was applied in distance learning in three primary schools in Kudus Regency, Central Java, Indonesia, each of which is located in remote area, suburban area and urban area. Seriousness in preparing to work on solving problems and being active in asking questions about things that are still difficult are the keys to obtaining a high score of scientific literacy.

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