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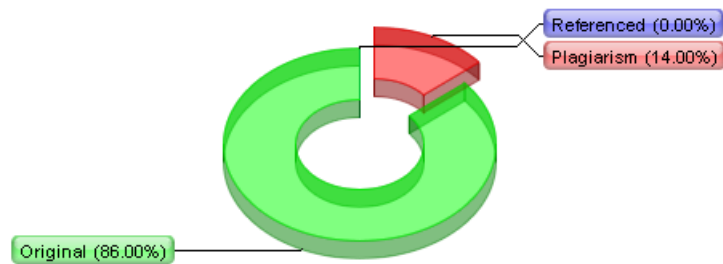
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LITERACY OF PROSPECTIVE BIOLOGY TEACHERS

DOI:


Accepted:

..Approved: .Published: .The present study aims

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to determine the effect of the scaffolding of information literacy on t

he botanical

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literacy of prospective biology teachers.

The current study employed an experimental method with a non-equivalent group design. The respondents comprised

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120 students in the Biology Education Program of Malang State Universit

y (the academic year 2017/2018),

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
divided into the control and experime

ntal groups. Data collection was based on scaffolding information literacy among prospective biology teachers and subsequent botanical literacy tests in multiple-choice format. The botanical literacy test provides nine indicator references. Reliability testing was done using Cronbach's alpha. Data were analyzed through pre-test covariate analysis ($p < 0.05$)

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for the control and experimental grou

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The present study indicates

that the scaffolding of information literacy has a significant effect on botanical literacy among prospective biology teachers. The findings of the current study suggest that innovation in botany learning, in this case, the scaffolding information

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literacy, can improve the botanical literacy of biology education

students. It is necessary to undertake learning innovation with biology education students in a professional manner to enable them to transfer knowledge using scaffolding information literacy to their prospective students. In conclusion, the scaffolding of information literacy has a significant effect on botanical literacy among prospective biology teachers. Keywords: botanical literacy; prospective; teachers; scaffolding information literacy

2021 Science Education Stu

dy Program FMIPA UNNES SemarangINT

RODUCTIONCurrently

, the global community faces significant challenges in many aspects, such as food, health, fuel, and the environment. Hemingway et al. (2011) noted that plants have essential roles in overcoming these problems. Plants play important roles daily both from the spiritual, economic, ecological, and socio-cultural aspects. In this regard, such challenges can be addressed by increasing botanical awareness among students. However, Leksono et al. (2013) pointed out that most biology teachers cannot design lessons properly due to the lack of understanding about Pedagogical Content Knowledge. It is the knowledge about how to facilitate student learning from botany.P

edagogic (pedagogic in research using

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scaffolding information literacy). As suggested b

y Drea (2011), the implication is improper botanical learning that leads to poor outcomes and threatens biodiversity. Uno (2009) also argued that the study of botany is threatened, leaving many students bereft because of improper lecture method in giving botanical material. Botany is taught by a lack of modern technology and a lack of effective practice, which reduces the students' interest and concern about plants. Therefore, botanical literacy among prospective biology teachers needs to be empowered and improved. Project-based learning

(PjBL) models implemented in basic botany courses for biology education students have not been found to affect their botanical literacy skills (Sari et al., 2018). The characteristic of PjBL is students are required to solve problems through projects by aiming at the product as the ultimate goal in studying the natural phenomena

related to plants that exist in the surrounding environment and does not require memorizing concepts. However, it is required to be more analytical and think critically by analyzing the information collected. The difficulty in understanding scientific literature is the major problem (Hubbard & Dunbar, 2017; Boholm & Larsson, 2019). In addition, students tend to employ untrustworthy reference sources. Porter (2005) stated that students are often unaware of the role of scientific papers in research processes. Moreover, lecturers do not support students with sufficient information regarding the crucial role of scientific materials. It is essential to introduce scientific-related aspects to students as early as possible through information literacy (Freeman & Lynd-Balta, 2010). The application of a PjBL model with the scaffolding of literacy is needed to empower botanical literacy. The scaffolding strategy is defined as an effort to assist students in learning activities during the early stages based on the difficulties experienced by the students (Bikmaz et al., 2010; Taber, 2018). Such assistance will gradually be removed with the increasing competence of the students. Assistance can comprise guidance, assignments, encouragement, and outline problems in the learning process, allowing the students to grow with greater independence. The scaffolding strategy plays a pivotal role in improving

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the regulation of learning and enha

ancing the performance and achievement of learning (Molenaar et al., 2011). This scaffolding information literacy will provide the earliest possible experience of the role of information literacy in prospective teachers because the information literacy will empower professional abilities. In addition, it is necessary to provide experience to prospective teachers on how

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to manage the learning process according to the student needs for learning outcomes. Scaffolding information literacy through assignments is vital in the learning process.

Several tasks, such as conducting a scientific reading, identifying and finding appropriate sources of information, analyzing the quality of the information obtained, and using information effectively, have been applied with prospective biology teachers. Cankaya et al. (2017) described information literacy as the ability to seek information, identify and find appropriate sources of information, evaluate and recognize information, and use information effectively (Venkataraman, 2014; Saglam et al., 2017). Therefore, this research aimed

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to identify the effect of the scaffolding of information literacy on t

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literacy of prospective biology teachers.

The present study was limited only to interpreting information about botanical literacy toward a prospective biology teacher in the first year. METHODS

Research Design and Sample Selection

The present study employed an experimental method with a non-equivalent group design. Samples were recruited using a random sampling. The first group was treated with a PjBL model, and the second group was treated with PjBL and scaffolding of information literacy. Each group, before treatment, will be tested pre-test and, after treatment, will be tested post-test. The research design is a 2 × 2 factorial experiment shown in Table 1. Table 1. The research

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uses a non-equivalent control group design Subject

Pre-test

Intervention

Post-test

Group 1

O

1X

1O

2Group 2

O

3X

2O

4Source: Leedy and Ormrod (2018) Information:

O

1: Pre-test in group 1 (PjBL model) O


2: Post-test in group 1 (PjBL model) O

3: Pre-test in group 2 (PjBL model + scaffolding of information literacy) O

4: Post-test in group 2 (PjBL model + scaffolding of information literacy) X


1: Treatment with the PjBL model X

2: Treatment with the PjBL model + scaffolding of information literacy The population comprised all students majoring in biology (the academic year 2017/2018) at Malang State University. A total of 120 biology students who take botany classes were used in the current study

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and divided into two groups (control and experimental). Application of Learning Model and Data Collection
A PjBL model was employed in both the control and experimental clas


ses; the scaffolding of information literacy was also applied in the experimental class. The scaffolding of information literacy was used as an instrument for collecting data based on several tasks. Those tasks are searching for scientific reading materials, i.e., reference books and scientific journals, from a list provided as part of a research project task, identifying and finding appropriate sources of scientific information, analyzing the critical quality of information obtained from three reference books and journals (a local paper and two international papers), and using the scientific literature

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information effectively. The Test of Scientific Literacy Skills (TO


SLS) can be used to

measure the scientific information and arguments in higher education, such as to evaluate biology teacher candidates who are focused on botanical literacy (Gormally et al., 2012). There were nine indicators, including: (

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1) identify a valid scientific argument; (2) evaluate the validity of sources; (3) evaluate the use and misuse of scientific information; (4) understand elements of research design and how they impact scientific findings/conclusions;


(5)

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create graphical representations of data; (6) read and interpret graphical representations of data; (7) solve problems using quantitative skills, including probability and statistics; (8) understand and interpret basic statistics; and (9) justify inferences, predictions, and conclusions based on quantitative

data. Technological literacy, world literacy, and critical literacy, including botanical literacy, are types of literacy concepts (Saglam et al., 2017; Uno, 2009). Information literacy has different characteristics from other literacy concepts. Information literacy supports all other types of literacy, such as scientific literacy. Information literacy plays an important role in the 21st century. Learning is a necessity to increase information literacy (Bhimani, 2011; Sural & Dedebali, 2018). In the present study, 30 multiple-choice questions were designed regarding predetermined learning outcomes. Data Analysis

The questions were designed for validity, reliability, difficulty, and differentiation of levels. Reliability testing was undertaken using Cronbach's alpha. The Cronbach's alpha coefficient was selected because it

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provided an estimate of the proportion of the observed score variance across the items on the test associated with the variance of the

actual score (De Champlain, 2010). The instruments consisted of a semester lesson plan and a student worksheet based on a PjBL approach. Botanical literacy was evaluated using statistical tests, including normality, homogeneity, and hypothesis tests. Statistical analysis was used to determine the data distribution, and then the data were analyzed using pre-test covariate analysis ($p < 0.05$). RESU

LTS AND DISCUSSION Table 1

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presents the results of the

analysis of covariance. F-value for scaffolding information literacy is 141.473 with a p-value of 0.000. Given the p-value is α ($\alpha = 0.05$), this is considered a significant difference. Thus, H_0 , which

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states that there will be no

difference in the application of

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scaffolding of information literacy, is rejected, and the research hypothesis stating that there is a difference in the application of scaffolding of information literacy is accepted.

Therefore, the scaffolding of information literacy affects botanical literacy significantly. Table 1

The effect of scaffolding information literacy on the botanical literacy of prospective biology teachers Source

Type III sum of squares Df

Mean square F

Sig.

Partial eta squared Corrected model 6422.652

a2

3211.326

150.282

0

.0000

.720Intercept

2904.833

1

2904.833

135.939

0

.0000

.537X

3570.777

1

3570.777

167.103

0

.0000

.588CLASS

3023.091

1

3023.091

141.473

0

.0000

.547Error

2500.140

117

21.369

Total

614553.000

120


Corrected total8922.792

119

Note:

aR-Squared = 0.720 (adjusted R-squared = 0.715)A corrected rate summary for each class is presented in Table 2. The results show that the level of botanical literacy among students receiving the scaffolding strategy is significantly higher than that in the control group. Table 2.

The corrected

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id: 23

rate of experimental and control classesGroup

Pre-test t

Post-test

t t

Interval

Enhancement

Corrected rateExperimental

54.933

75.917

20.983

38.20%

76.063

Control

55.367


66.167

10.800

19.51%

66.021

The mean for botanical literacy among prospective biology

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teachers in the experimental class increased

by 38.20% on the post-test result, whereas the control class experienced an increase of 19.51%, lower than the experimental class. PjBL

was applied

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in both the experimental and control groups. In contrast, the scaffolding of information literacy was applied only in the experimental group and was found to have a significant effect on the botanical literacy of prospective biology teachers in this group compared with the control group.

roup. Skill in botanical literacy is measured based on the nine indicators in the TOSLS instrument, as follows: (1)

identification of valid scientific arguments; (2) use and evaluation of effective sources of information; (3) differentiation of the presence or absence of scientific information; (4) understanding

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of the elements of research design and how it impacts scientific findings/c

onclusions; (5) creation of

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a graphical representation of the data; (6) reading and interpretation of the graphical representation of the data;

(7)

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problem-solving process using quantitative skills, including probability and statistics;

(8) understanding and interpretation of basic statistics; and (9) justification of inferences, predictions, and conclusions employing quantitative data. Based on our observations, in the first semester of the structure of plant development class, the prospective biology teachers still had significant problems in understanding basic botany. For example, students readily understood that transportation tissues in plants consist of the xylem and phloem. However, it was an entirely different matter when the question was changed as to why the angiosperms group is more dominant than other plants regarding transportation tissue structure. Uno (2009) affirmed that teachers in biology classes generally over-emphasize vocabulary practice, which focuses on definitions and labeling, as well as recognizes the correct answer in learning science. Students with high memorization skills are commonly greatly appreciated for their thinking, analytical, and evaluative skills. However, commonly, while such memorization skills are helpful for students during examinations, the information is not retained after the test, and thus students often fail to show botanical literacy. High-level thinking skills promote the conceptual understanding of botany in both students and citizens. Botany is a science gained

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through the process of investigation, and therefore it is necessary to

provide more opportunities for students to do the science themselves. Thus, the PjBL approach is a solution as an innovative learning model to develop the investigative activities of prospective biology teachers. According to Table 2, botanical literacy increased in both the scaffolding and non-scaffolding groups. The mean of botanical literacy for prospective biology

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teachers in the experimental class increased by 38.20% on the post-test results, whereas the control class increased

by 19.51%, lower than the experimental class. The application of the PjBL model improves the quality of learning and contributes to higher levels of cognitive development (Lasauskiene & Rauduvaite, 2015; Saripudin et al., 2015; Syukriah et al., 2020). However, the project-oriented learning model requires the students to enrich their learning with relevant concepts. The application of the PjBL model necessitates that students integrate knowledge from various information sources and several related disciplines, including scientific materials, such as books and papers, through scaffolding information literacy. PjBL naturally requires many academic skills, such as understanding scientific articles, writing, and processing data using appropriate statistics, in constructing conceptual understanding through assimilating subjects in different ways (Zajkov & Mitrevski, 2012; Capraro et al., 2013). The botanical literacy

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skills of prospective biology teachers

with the application of the scaffolding strategy were significantly higher than those of prospective teachers in the control group (Table 2). The TOSLS instrument developed by Gormally et al. (2012) measured the evaluation of scientific information and arguments among undergraduate students. The opportunities to develop skills such as argumentation and scientific reasoning are significant but tend to be

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neglected in the education system.

Moreover, the stages of the PjBL model begin focusing on a question or problem (Tamim & Grant, 2013; Aldabbus, 2018). Based on these opinions, it is apparent that the stages of the PjBL model are compatible with the TOSLS instrument in the following respects: (1) identifying valid scientific arguments; (2) using and evaluating effective sources of information; (3) distinguishing the presence or absence of scientific information; and (4) understanding the elements of research design and how this affects scientific findings/conclusions. However, as indicated by Sari et al. (2018), the PjBL model itself does not affect botanical literacy. The present study reveals the difficulties for prospective biology teachers in understanding and analyzing critical scientific papers in the PjBL stage, such as in botany learning. It is a science that involved the investigation process. Students have high opportunity to find their own concepts. Thus, the PjBL approach is an innovative learning model for developing

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the activities of prospective biology teachers.


Therefore, the scaffolding of information literacy is needed. Specific skills, such as reading, understanding, and

interpreting scientific articles, are the most difficult tasks for students (Porter, 2005; Alghail & Mahfoodh, 2016). Thus, the

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
scaffolding of information literacy is integrated into the learning process through a PjBL model. The scaffolding of information

literacy is needed to simplify the acquisition of information literacy skills by prospective biology teachers, which reduces the complexity through assignments and guidance from lecturers. Scaffolding provides some assistance to solve problems during the initial stage of learning and an opportunity to become independent gradually. It requires a lecturer (or a more experienced peer) as a pedagogical agent to diagnose, clarify, and guide the learning task. Scaffolding can be both static and dynamic. According to Molenaar et al. (2011), in static scaffolding, the lecturer does not assist but only gives instructions that help in learning activities for all students. Dynamic scaffolding requires pedagogical agents to diagnose, clarify, and provide support for learning tasks (i.e., monitoring students' learning progress and providing scaffolding when required in the learning process). In an innovative learning setting, both static and dynamic scaffolding can support and improve the regulation of cognitive activity, in turn improving learning and attainment (van de Pol et al., 2010; Wu et al., 2017). Mishra (2013) also defined scaffolding as a concept closely related to the idea of the Zone of Proximal Development (ZPD). In the PjBL model, students need to study and work in groups according to their ZPD and require the assistance of lecturers or skilled colleagues, based on which they can become increasingly independent. A component

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
of the scaffolding of information literacy in the

present study was analyzing and critiquing the quality of information obtained from a local paper and two international papers during a semester. The information in recent bibliographic and internet sources is often untrustworthy. Instruction in biological information helps the development of greater depth in the criticality of learning materials and assessment. Similar to Porter (2005), more attention regarding focus and time was given to students over a semester for assignments and project-based work. In addition, scaffolding information literacy plays a vital role in evaluating the quality of research papers through scientific writing. Scientific writing assistance was undertaken to guide prospective biology teachers as an outcome of the PjBL model. Plagiarism is a fraud and in violation of legitimate dealing. Scaffolding information literacy is correlated with the second indicator of TOSLS, which covers organizing, analyzing,

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and interpreting quantitative data and scientific information. Specifically, the TOSLS sub-indicators include: (1) organizing, analyzing, and interpreting quantitative data and scientific information; (2) creating graphical representations of data; (3) reading and interpreting graphical representations of data; (4) solving problems using quantitative skills, including probability and statistics; (5) understanding and interpreting basic statistics; and (6) justifying inferences, predictions, and conclusions based on quantitative

data. Uno (2009) emphasized that botanical literacy needs to be enhanced among prospective biology teachers. Botanical literacy is concerned with the economic welfare of a country related to food in the international market. These days, countries need a supply of scientists, engineers, and technically trained personnel to produce new high-tech products. To enhance botanical literacy, students need solid foundations for building science experience, understanding the scientific process, and conducting investigations that lead to an understanding of biological content. Another key to improving botanical and scientific literacy is through investigative instruction, which has been advocated for years by several publications and science education groups; one of these is project-based

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modeling. The results of the present study showe

d that scaffolding information literacy to develop botanical literacy led to significantly higher

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
scores in the experimental class than in the control class.

Saglam et al. (2017) stated that there are many different concepts of literacy, such as technological literacy, world literacy, and critical literacy, including botanical literacy, as introduced by Uno (2009). Information literacy has characteristics that differ from those of other literacy concepts: information literacy can influence and support all other types of literacy. Information literacy was considered an essential ability in the 21st century, and in this regard, learning was a necessity, paving the way for enhancing information literacy (Bhimani, 2011; Sural & Dedebali, 2018). The development

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of information technology in the 21st century shows the increasing importance of information literacy.

Previously, information sources were dominated by print media, such as books, newspapers, journals, and offline government-based publications, but now information is available in more diverse forms, such as via databases and the internet. The development of information technology has had a substantial impact on education and will continue to change the methods of learning, programs, and the


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roles of teachers and students

(Saglam et al., 2017; Ratheeswari, 2018). Owing to the need for education in the 21st century, it is necessary to inculcate the competencies required for teachers to become literate, mainly using instructional technology in the learning process. Drea

(2011) noted that botanical literacy among prospective biology teachers needs to be improved due to the importance of food security and biodiversity issues. It may be possible to utilize and exploit food safety and the threat of biodiversity to highlight its relevance. The role of plants is related to the survival of humankind. This notion can be embedded in learning activities at the school level, ultimately providing more effective opportunities for exploitation in the higher education system. To address today's food crisis and prospects is necessary. Some studies that have been done in recent years have shown an alarming decline in botanical studies in higher education institutes. CONC

LUSION The present study indicates that the scaffolding of information literacy has a significant effect on botanical literacy among prospective biology teachers. The findings of the current study suggest that innovation in botany learning, in this case, scaffolding scientific

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literacy, can improve the botanical literacy of biology education


students. It is necessary to undertake learning innovation with biology education students in a professional manner to enable them to transfer knowledge using scaffolding information literacy to their prospective students. REFERENCES

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LITERACY OF PROSPECTIVE BIOLOGY TEACHERS

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Guidelines

Yes

Partly

No

Reviewer's note for improvement

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Title

Does the subject matter fit within the scope of the journal?Does the title clearly and sufficiently reflect its contents?

The redundant words might be a bit confusing to the readers, but it is not a serious issue.Abstract

Does the abstract contain information including Background, Methods, Results, and Conclusion? Does scaffolding scientific literacy differ from scaffolding information literacy? Background

Is the background informative and sufficient (include the background problem and objectives)?

Need to explain more about scaffolding information literacy and botanical literacy. Is the research question of the study clear and understandable? Does the rationale of the study clearly explained using relevant literature?

Why is botanical literacy important, and what is it? How is it different from scientific literacy? Is the

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"aim"

of the manuscript clear and understandable?

Methods

Is the methodology selected suitable to the nature of the topic studied? Add sampling method

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. Is the methodology of the

research described clearly

(including study design, location, subjects, data collection, data analysis)? Understandable but need more details

. Is there adequate information about the data collection tools used? (only for empirical studies)

Why can TOSLS measure botanical literacy? What is the similarity or difference of the two literacies? Are the validity and reliability of data collection tools established? (only for empirical studies)

Are the data collection tools suitable

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for the methodology of the

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Results &

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, and pictures understandable, well presented, and numbered consecutively? Are the data analysis and the interpretation appropriate to the problem and answer the objectives? Does the

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section of the manuscript adequately relate to the current and relevant literature? Are the findings discussed adequately considering the research question(s), sub-question(s)

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project-based learning appears to be important in some degree. In this part, PjBL is cited more so the researchers should clarify how important PjBL is and how scaffolding information literacy can be used in other teaching model Conclusion Is the conclusion clear and in the form of a narration instead of pointers?

Isn't the conclusion a summary and consistent between problems, objectives

, and conclusion? References

Do the references and citations match?

Are the writing of references correct? Quality Criteria

Are the title, problem, objectives, methods, and conclusion in line? Is it well organized? Is t

he quality of the language satisfactory? Is t

he work relevant and novel? Are there strong consistencies among the parts of the manuscript (introduction, methods, results and discussion, and conclusion)

? Some terminology is inconsistent

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