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Biology Learning Based on *Socio-Scientific Inquiry*: Development of Student Worksheets for Understanding the Concept of Biodiversity

Miftahuddin Miftahuddin(*), Ummi Nur Afinni Dwi Jayanti

Biology Education of Faculty of Tarbiyah and Teacher Training,
Universitas Islam Negeri Sumatera Utara
Jl. William Iskandar Pasar V, Medan Estate, Deli Serdang Regency,
North of Sumatera 20221, Indonesia

***Corresponding author:** miftahuddin@uinsu.com

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Abstract

In general, if students do not understand the concept of learning, it affects learning. Therefore, there is a need for teaching materials that convey to students the need to understand concepts when learning. This development research aims to produce student worksheets based on Socio Scientific Inquiry that are valid, practical, effective for students, student sheets, media and material expert validation sheets, as well as practicality sheets. Then the effectiveness sheets are in the form of post-test and pretest sheets. Based on the data obtained, the validation of teaching materials had a score of 95.76 %, the results of material validation were 100 %, the teacher response results were 100% and the student response questionnaire results were 95.32 %. The effectiveness assessment resulted in an N-Get of 75.52 % in the high category. Therefore, it can be said that the Socio Scientific Inquiry of worksheet is an available, functional, and efficient learning tool that can improve students' conceptual comprehension. However, additional research development can increase the topic of study and include biological learning materials not covered in this worksheet.

Keywords: *Socio Scientific Inquiry; Understanding of concepts; Worksheet development*

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INTRODUCTION

One of the efforts is by promoting sustainable development planning (Sustainable Development Goals/SDGs), it is crucial for us to protect nature with its various biodiversities (Agustina, 2010). The concept of development that balances economic, social, and environmental aspects while considering the requirements of present and

future generations is known as sustainable development planning (Suparmoko, 2020). One of the objectives of the Sustainable Development Goals program (called as SDGs) is high-quality education.

The goal of SDGs is to create sustainable development by maintaining various aspects, one of which is supporting the quality of the environment, through efforts to preserve nature, wise management of natural resources, reducing pollution, and protecting biodiversity which is studied in Biology Education. However, behind its beauty, Indonesia has various problems that threaten the land and seas in Indonesia. SDGs No. 14, 15 which is a global program by the national examination (called as UN) emphasizes explicitly the importance of maintaining and sustainably utilizing marine and land resources (Safitri et al., 2022; Panuluh & Fitri, 2016).

According to Baswedan (2014) quoted that in addition to being one of the ten lowest-performing nations in the 2013 Learning Curve meta-analysis, 75% of Indonesia's educational institutions do not satisfy the requirements for minimal education services. To overcome these conditions, the SDGs Program will be the foundation for improving the quality of education in the world where Indonesia is one of the participating countries. Mulyasa (2005) SDGs are expected after the process of discussing materials and learning activities, students will be able to take actions that are beneficial to society and responsible for the surrounding environment.

Their comprehension of biological ideas will impact students' comprehension of biological events in the context of daily life (Shen et al., 2018). Understanding biological concepts that certainly realize the SDGs focuses on biodiversity material, because biodiversity underlies many SDGs, each of which discusses life underwater and life on land. ESD greatly enhances students' awareness and comprehension of the SDGs' objectives and urgency. Biodiversity and ecosystems stability can encourage the development of cost-effective and resilient natural infrastructure to help sustainable industrialization (Tristananda, 2018). Analysis of Biology teaching materials with a sustainable approach includes examining how teaching materials cover the SDGs goals set by the national examination (UN) (Fitria, 2022).

However, the facts on the ground show students' lack of seriousness and interest in the learning process, resulting in students being unable to accept the concept correctly. The results of Amalia et al., (2020) stated that students' conceptual understanding of the material on biodiversity was still low in each indicator because there were misconceptions, the concepts underlying diversity were not adequately understood by students, and they tended to memorize the material. In line with the opinion of Kurniasih (2017) that students who understand the concept not only remember but can also explain information about the concept in their own language according to the answer choices provided.

The results of interviews with biology teachers showed that the influence of students' conceptual understanding is greatly influenced by each student's conceptual ability or each student's interpretation of a concept Sudijono (2013) and has a negative impact, namely it can affect learning interest and will affect student learning outcomes. In line with research by Azizah & Alberida (2021), one of the problems in biology learning is the incompatibility of students' conceptual understanding. This is also supported by the results of observations at one of the MA Batang Kuis schools which

stated that 70 % of students at the school had low biology learning outcomes in biology subjects, especially biodiversity material. Efforts to solve problems with students' conceptual understanding of biology learning by implementing Socio-Scientific Inquiry which aims to encourage students' abilities to produce contextual work, both individually and in groups. Inquiry focuses on describing, explaining, predicting, and communicating scientific phenomena (Harrison & Treagust, 2000).

Socio-Scientific Inquiry is a newly developed scientific inquiry learning and is becoming a trend in content context learning that is expected to be able to improve the quality of learning optimally (Zeidler, 2009) SSI can combine authentic research questions that arise from student interests, relevant socio-scientific scenarios, and pedagogical strategies to support student interest and commitment (Kinslow et al., 2018). By allowing students to practice applying scientific ideas and principles in scenarios that are comparable to those they will encounter as citizens of a scientific society in the future, SSI-based teaching improves the educational experience for students.

In learning, it is important to use media for an interesting and enjoyable, non-boring learning process (Tafanao, 2018), Worksheet which called as LKPD is one of the means to help and facilitate learning activities. According to Wenning (2011), the multilevel inquiry learning model is an approach that encourages the development of intelligence and scientific skills through systematic and comprehensive investigations. and explains the context of biology learning according to everyday life facts. Previous research conducted by Rohmah et al., (2021) on the development of biodiversity teaching materials based on Socio-scientific issues has proven to be very valid and feasible in improving learning outcomes. In the research of Subiantoro et al., (2013); Prima & Kaniawati (2014) biology learning based on socio-scientific issues (SSI) has an effect on students' conceptual understanding and can improve student learning outcomes. From previous research, no research has been found that discusses explicitly biodiversity material to measure students' conceptual understanding. Therefore, there is an opportunity for researchers to conduct research that focuses on the innovation of the socio-scientific issue model with socio-scientific inquiry.

From the results of observations at MA YPI Batang Kuis Islamic Senior High School, it is known that biology teachers more often use lecture methods than the application of varied learning models, so that students experience misconceptions, and lack of understanding of student concepts seen from the results of student answers. Based on the background explanation, this study aims to develop valid, practical, and effective Socio Scientific Inquiry-based LKPD on biodiversity material. This study is expected to be one of the references for implementing learning rules that direct socio-scientific inquiry on Biology material.

METHOD

Research and development is the term for this kind of study. This study's procedures follow those of Sugiyono (2009). Twenty-five students in first grade (as X-class) of the MA YPI Batang Kuis Islamic Senior High School served as the research subjects for this study, which was conducted at one of the Batang Kuis Islamic

Senior High Schools. The research instruments used include needs analysis questionnaires for students and teacher interview sheets. The practicality of the media is then evaluated using a student response questionnaire, and the media's validity is tested using a validation sheet that includes two versions: one for media experts and one for material specialists. Stages carried out in the 4D development model (Thiagarajan et al., 1974):

1. Definition (define), which includes student, task, and idea analysis, learning objective creation, and preliminary analysis by focusing on the facts that surface to ascertain the suitability of the product to be generated.
2. Design, determining the media/products to be developed, namely LKPD based on Socio Scientific Inquiry, and selecting the presentation format.
3. This development (develop) is related to the process of assessing the feasibility of LKPD. The instruments used are in the form of design feasibility questionnaire sheets and material feasibility questionnaires. The aspects assessed in the design feasibility questionnaire include; suitability of size, layout, color, and letters in the LKPD. While the aspects assessed in the material feasibility questionnaire include; presenting KD and KI according to the material with the 2013 curriculum content standards, cases, data and facts.

Likert scales are used in data analysis methods for validity checks.with a range of 1 to 5 and the following formula 1 (Ikhwani & Kuntjoro, 2021) for each question's with 1 to 5 choices:

$$P = \frac{\text{Score an each answer of question}}{\text{total of ideal item score}} \text{ x } 100\ \% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

According to Dermawati et al., (2019), the following criteria are used to interpret the results: 0–20 as not valid category, 21–40 as valid category, 41–60 as valid category, 61–80 as valid category, and 81–100 as highly valid category. To determine percentage, many students who responded to each category that was asked in the questionnaire sheet used the two corrections for percentages (Purwanto, 2012) as follows:

$$NP = \frac{R}{SM} \text{ x } 100\ \% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Information:
NP : Expected Percentage Value
R : Score obtained
SM : Maximum score

Following percentage, grouping is carried out in accordance with the criterion for achieving practicality. If the student's response falls between 81-100 %, it is said to be very practical. If 61-81 % is in the practical category, If 41–60 % is less practical category. If 20–40 % are not practical category, and If less than 20 % are not practicing (Husnita et al., 2021).

Analysis of effectiveness is based on student achievement at the time of learning. Pretest and posttest results are used to gauge the effectiveness of new products

during the field test.

$$N - gain\ (\%) = \frac{(skor\ postest - skor\ pretest)}{(skor\ maksimal - skor\ pretest)}\ \text{x}\ 100\% \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

To determine if the LKPD is successful or not in evaluating learning outcomes process, a comparison of the normalized N-gain or N-gain equation refers to Yunipiyanto et al., (2020), where the N-gain results normalized score are divided into three categories: N-gain < 0.3 as less effective category, 0.3 ≤ N-gain ≤ 0.7 as quite effective category, and N-gain > 0.7 as Effective category.

RESULTS AND DISCUSSION

This development research creates educational materials in the form of LKPD based on biodiversity-related socio scientific inquiry. The Socio Scientific Inquiry-based LKPD was developed to help students grasp the concepts. Based on the 4D development paradigm, this study employed four stages (Thiagarajan et al., 1974). The results of this study's LKPD development stages (define, design, develop) are explained as follows.

Define

The five main procedures that make up the defining stage are initial analysis, student analysis, concept analysis, task analysis, and goal analysis. The goal of this step is to find and define needs in the learning process.

Front End Analysis

Development research is based on the kind of analysis known as front-end analysis. The first analysis was done by looking at the biology learning environment at MA YPI Batang Kuis senior high school. The first study was conducted by interviewing biology teachers and using questionnaires to look at the needs of both teachers and students. Improving students' high-level thinking abilities requires creating media in the form of student worksheets (LKPD) based on learning models. The observation's findings demonstrated that instructors continue to use the lecture method, the curriculum from 2013 is still used in the classroom, and there is still a lack of media in the classroom, especially in the form of LKS. According to Budiarti & Haryanto (2016), instruction that utilizes.

Student Analysis

To complement the planned learning process, student analysis is used to ascertain the demands of the subjects being studied. The student needs analysis questionnaire results show that students don't fully grasp topics, the learning process isn't as engaging, and there isn't enough media in the classroom. As seen by the Monthly Exam (UB) results, students are less engaged in their education, ask questions infrequently, and respond poorly to teacher explanations.

Concept Analysis

This study aims to create learning objectives, identify key topics to be studied,

and gather pertinent resources based on fundamental competencies. After examination, the first grade (grade X) biodiversity material was created in the LKPD using Socio-Scientific Inquiry. Basic Competency (KD) 3.2 specifies the biodiversity material to be prepared, which entails assessing Indonesia's biodiversity at different levels as well as threats to and preservation of that biodiversity. Identifying biodiversity (Biodiversity), identifying types of biodiversity, explaining differences in diversity at the gene, species, and ecosystem levels, analyzing forms of biodiversity conservation efforts, and presenting data on biodiversity conservation efforts are the indicators of competency achievement that must be met.

Task Analysis

The purpose of task analysis is to identify the activities that can potentially influence concept understanding. Creating competency achievement indicators in KD 4.2 is how this analysis is carried out. presenting the findings of observations of Indonesia's biodiversity at different levels and suggestions for conservation initiatives. Task analysis activities can be seen in Table 1.

Table 1. Competency Achievement Indicators

Basic Competencies (KD)	Core Competencies (KI)
4.2 presents the results of observations of various levels of biodiversity in Indonesia and proposed conservation efforts.	4.2.1 Present data on biodiversity conservation efforts in Indonesia based on correct observations of problems.

Objective Analysis

At this point, learning objectives are formulated and modified in accordance with the anticipated learning outcomes and the findings of the analysis that has been conducted. The learning objectives to be achieved in this Socio-Scientific Inquiry model LKPD are:

1) Students can identify biodiversity;
2) Students can identify various types of biodiversity.

Design

At the design stage, researchers started creating the LKPD using Socio-Scientific Inquiry, taking into account the LKPD's components, including language, content, appearance, and compatibility with the issue-based learning paradigm. Beginning with the LKPD cover, the product is prepared by presenting the indicators, learning instructions, core and basic competencies, and resources together with pertinent picture media. At this point, the Canva and Microsoft Word programs were used to create visually appealing color gradients and graphics for the LKDP. Socio-scientific inquiry is divided into three stages: Ask, which poses real questions about problems; Find Out, where students look at and identify problems based on the examples given; and Act, which. The results of the product development design are presented in Figure 1.

(a) Cover

(b) Syntax

(c) Instructions

(d) Material content

Figure 1. LKPD Product Design - Socio-Scientific Inquiry

Develop

LKPD product development and validation activities are conducted in the third stage, which is called the Develop stage. The validation results, which were conducted by media and material specialists, are displayed in Table 2. The findings of the validation of media experts and teaching materials for the LKPD were 95.76 % following the development and input from the validator during the revision, suggesting

that the LKPD based on Socio Scientific Inquiry was deemed to be very legitimate. The validator's comments and answers were intended to ascertain the LKPD's viability in light of the Socio Scientific Inquiry that had been created prior to the field test.

Table 2. Media and Material Validation Results

Aspect	Percentage (%)	Category
Validation of media experts and teaching materials	95.76	Very valid
Subject matter expert validation	100	Very valid
Category		**Very Valid**

The results of this study are in accordance with the notion expressed by Arsyad (2002) that learning media can increase and direct children's attention so that it can produce learning motivation. In the meantime, the material experts' validation results were 100%, indicating that the LKPD was regarded as. The material presented with high scores was accompanied by material content that was related to life and the surrounding conditions. Without doing, children do not think, so that they think for themselves they must be given the opportunity to do it themselves.

With the development of LKPD based on Socio Scientific Inquiry with an attractive design, it can provide student responses in teaching and learning activities. This is consistent with earlier research (Mayasari et al., 2023), which found that engaging learning designs can motivate students to finish the LKPD and give them feedback to participate in class discussions actively. However, in response to the validator's requests, both media and material experts proposed enhancements to the LKPD, which are shown in Figures 2, 3, and 4.

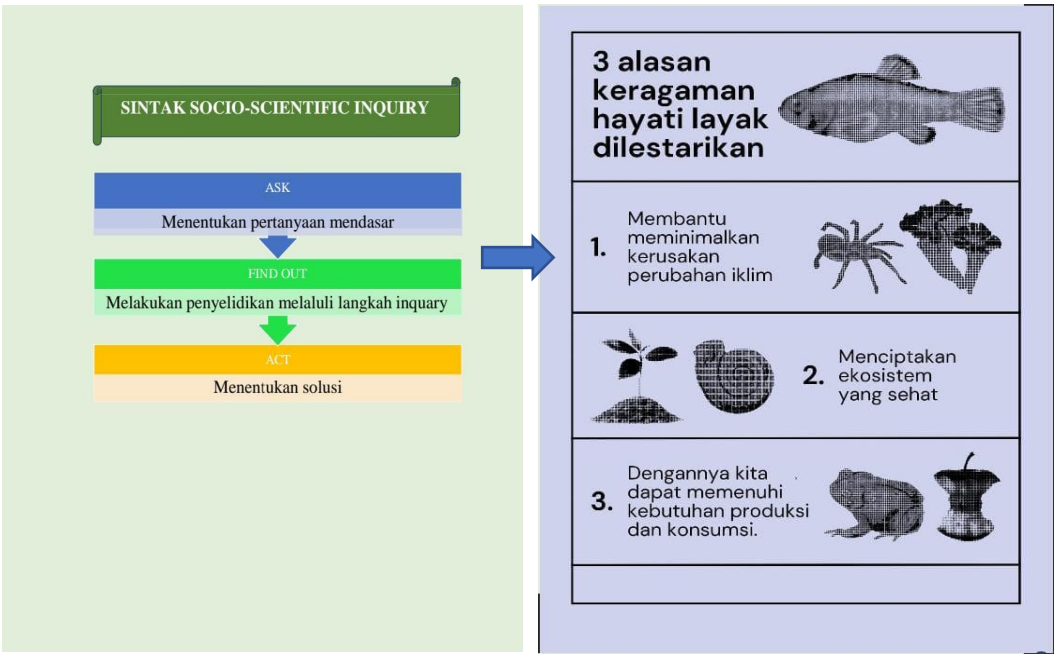

Figure 2. Image fix based on validator's suggestion to make SSI syntax indicators clearer

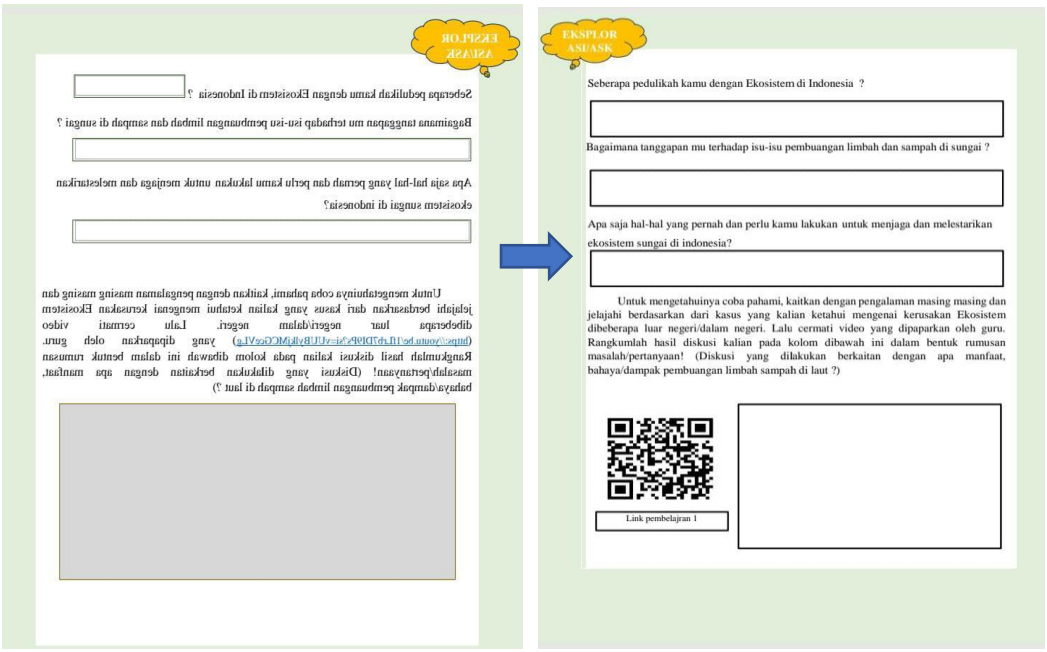

Figure 3. Addition of video link material in the form of a QR code and color changes in the answer column

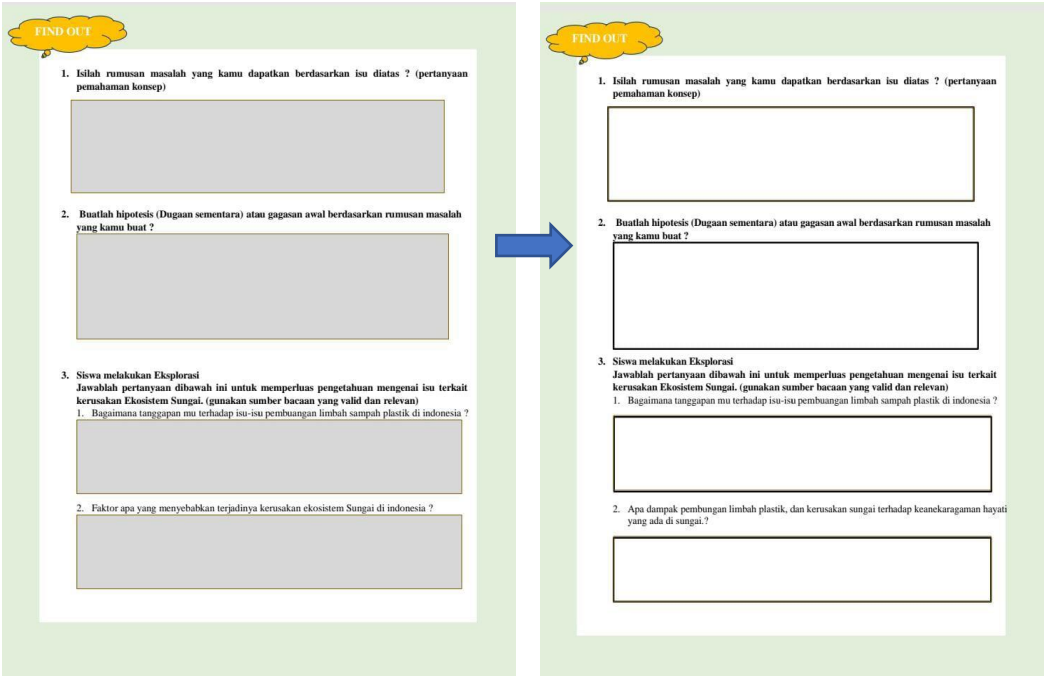

Figure 4. Revise questions to suit students' conceptual understanding

After the teaching materials are valid, a small-scale trial is conducted by distributing questionnaires containing teacher and student responses. The practicality data of teacher and student responses are shown in table 3. The biology teacher response questionnaire gives LKPD a perfect score of 100 %, indicating that it is highly

useful for teaching. Because it can be employed in the learning process and comes with resources to aid students in understanding the idea, LKPD is categorized as practical. Every piece of content offered in LKPD uses pictures to help students grasp the material's structure, and the writing style is very easy to comprehend.

Table 3. Teacher and Student Responses

Respondents	**Percentage (%)**	**Category**
Biology teacher	100	Very practical
Student	95.32	Very practical
Category		**Very practical**

This is in accordance with Rahman & Malihah (2021) statement showing that good communication can facilitate the information conveyed by both the recipient of the message and the sender of the information. As a result, communicating using appropriate language and sentences can help pupils understand the subject offered by the teacher. In the meantime, it is known that the results of the student questionnaire, which had a score of 95.32 %, are categorized as extremely practical. According to the overall assessment results, the LKPD that was developed fulfills practical standards. This supports previous research with an average practicality result of 87.5 % very good criteria (Elfina & Sylvia, 2020). The study results demonstrated that the usage of LKPD based on Socio-Scientific Inquiry has a positive association with student replies, as indicated by the outcomes of student responses that are fairly good or favorable.

Table 4. Concept Understanding

Pretest	**Posttest**	**Gain (%)**	**Criteria**
33	83.6	75.52	Effective

One class at MA YPI Batang Kuis had an effectiveness test after the validation and practicality process. The effectiveness of LKPD based on Socio Scientific Inquiry is proven through pretest-posttest analysis to measure the ability to understand concepts, as seen in Figure 4. Table 4 shows how well students understand concepts. With a percentage of N-Gain scores of 75.52 %, the N-Gain results show that students' pretest scores are lower than their post-test scores, indicating a successful category level. In the pretest-posttest questions, participants are directed to a problem in students' real lives and students can provide answers by linking the material to everyday life, so it can be said that students can think openly.

This efficacy test was designed to improve students' conceptual knowledge, as seen by the pretest and posttest scores in X-class. The pretest and posttest were given based on indicators of conceptual understanding. The enhanced results were obtained after the learning activities were completed using the designed media, namely LKPD based on Socio Scientific Inquiry. The main impact of learning to achieve a concept is that students acquire the concept as one part of the object of knowledge

(Ratumanan, 2015). According to Silver et al., (2012), the use of LKPD learning materials which are based on socio-scientific inquiry has been shown to be successful in enhancing students' conceptual understanding.

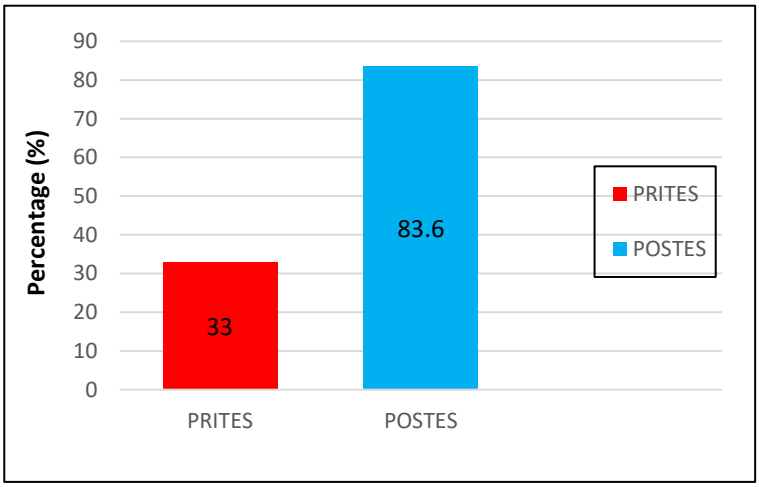

Figure 5. Pretest-Posttest Diagram

This is due to the fact that throughout the teaching process, there are activities that can make students more engaged in the learning process, such as discovery and thinking to address any issues that may arise. This is consistent with the results of a study by Rahayu & Hardini (2019); Khairani & Projosantoso (2023), which showed that if Socio Scientific Inquiry is applied correctly and all the requirements of the Socio Scientific learning models are understood, it can improve learning outcomes and student engagement.

CONCLUSION

Based on the completed research, the worksheet (LKPD) based on Socio Scientific Inquiry is an endeavor to provide educational materials that are reliable, useful, and effective in order to increase students' understanding of the Biodiversity material. Thus, education that makes use of the Socio-Scientific Inquiry approach can shed light on scholarly writing and explain the context of biology education that is in line with everyday facts. Nevertheless, this study still has limitations and aspects of testing for a larger population scale and varied ability measurement variables. As a result of this, the conclusion drawn by the researchers is that they can influence the public's opinion toward the implementation of LKPD in senior high schools level.

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