



STEM Based Student Worksheets to Improve Ecosystem Material Critical Thinking

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ABSTRAK

Pengembangan LKPD berbasis STEM didasari oleh media pembelajaran SMA yang kurang bisa membantu meningkatkan kemampuan berpikir kritis siswa kelas X. Kemampuan berpikir kritis siswa yang rendah berdampak pada hasil belajar siswa yang kurang optimal. Tujuan penelitian ini ialah mengembangkan LKPD berbasis STEM untuk meningkatkan kemampuan berpikir kritis yang layak, praktis dan efektif. Model penelitian pengembangan 4D (define, design, development, disseminate). Pengumpulan data dengan metode observasi, wawancara dan kuesioner. Instrument yang digunakan dalam mengumpulkan data yaitu lembar kuesioner. Teknik analisis data dengan analisis kuantitatif dan kualitatif. Subjek uji coba ialah 22 siswa kelas. Analisis data kuantitatif digunakan dalam melihat kevalidan, kepraktisan serta keefektifan LKPD. Analisis kualitatif digunakan untuk melihat saran, revisi dan hasil observasi. Hasil penelitian LKPD dinyatakan valid berdasarkan hasil penilaian oleh 2 ahli yakni ahli media 92,3% dan ahli materi 91%, dengan kategori sangat valid. LKPD dinyatakan praktis dengan hasil respon guru dan peserta didik melalui angket yakni guru 100% dan peserta didik 99,24% dengan kategori sangat praktis. LKPD juga efektif untuk meningkatkan kemampuan berpikir kritis dilihat dari hasil N-Gain rata-rata 0,92 dengan kategori efektif. Disimpulkan bahwa LKPD berbasis STEM dapat meningkatkan kemampuan berpikir kritis pada siswa.

ABSTRACT

The development of STEM-based LKPD is manifested in high school learning media which cannot help improve the critical thinking skills of class X students. Students' low critical thinking ability impacts learning outcomes that could be more optimal. The purpose of this research is to develop STEM-based worksheets to improve critical thinking skills that are feasible, practical and effective. 4D development research model (define, design, develop, disseminate). Collecting data with the method of observation, interviews and questionnaires. The instrument used in collecting data is a questionnaire sheet. Data analysis techniques with quantitative and qualitative analysis. The test subjects were 22 graders. Quantitative data analysis is used to see the validity, practicality and effectiveness of LKPD. Qualitative analysis is used to see suggestions, revisions and observation results. The results of the LKPD research were declared valid based on the assessment results by 2 experts, namely media experts 92.3% and material experts 91%, with a very valid category. LKPD was stated to be practical with the results of teacher and student responses through the channel, namely 100% teachers and 99.24% students with a very practical category. LKPD is also effective for improving critical thinking skills seen from the average N-Gain result of 0.92 in the effective category. It was concluded that STEM-based LKPD could improve students' critical thinking skills.

1. INTRODUCTION

Education is a learning process that is able to develop the potential that exists in students (Khadijah et al., 2022; Osberg & Biesta, 2021; Sia & Abbas Adamu, 2020). One of the important subjects in education is biology (Bettencourt et al., 2011; Safira et al., 2018; Weng et al., 2019). The purpose of learning biology is for students to understand, find and explain concepts, principles in biology. But in reality, there are still students who do not understand and explain a concept problem in biology. Science trains students to think critically and objectively and helps students learn to solve problems related to their daily lives (Agustina et al., 2016; Astatin & Nurcahyo, 2016; Melda et al., 2021). The learning system of the 21st century requires students to develop thinking and learning skills, problem solving, critical thinking, cooperation and communication skills. Curriculum 13 cannot be a solution to the problem of the quality of Indonesian human resources in facing global competition if it does not develop the knowledge, attitudes or demands that are required in the 21st century. An example is STEM, STEM can help in creating a quality generation. Therefore, STEM can be a reference in Indonesian education. (Manosutrit, 2019; Pangesti et al., 2017; Sartika, 2019).

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Effective integrated STEM learning significantly improves students' scientific thinking abilities (Agustine et al., 2020; Indrianingrum et al., 2018; Pratiwi et al., 2021). Lestari (2018) conducts research on teaching materials by integrating STEM which proven to improve critical thinking skills. Inquiry-based STEM can make students' thinking skills increase in learning (Almuhamarah et al., 2019; Onsee & Nuangchalerm, 2019). STEM is able to stimulate KBK students through the evaluating stage (Lestari, et al., 2018). KBK students experienced an increase after deployment of STEM learning in the high category. Most students respond well to learning using STEM and show a positive interest in STEM. STEM has really succeeded in making critical thinking increase. STEM implementation effectively improves critical thinking skills (Ritonga & Zulkarnain, 2021).

Based on the results of observations made at Al Ma'shum Kisaran High School, West Kisaran District, Asahan Regency, it was found that in the learning process, students only focused on material from the teacher and textbooks. The absence of other learning resources that support the learning process, this causes low students' critical thinking skills which require students to be capable of problem solving, explaining and concluding. Low level of critical thinking ability can be because of learning activities that are still dominated by teachers (Tita Kartika et al., 2020). Research Worksheets that have been used so far only make questions such as question banks, types of button questions, and very minimal media in the worksheet. Worksheets that are monotonous, look less attractive, lack pictures, unclear instructions, too many questions can make students bored and make it difficult for them to learn (Wiranata & Sujana, 2021). Of course this will have an impact on students' critical thinking skills. Students who still have difficulty mastering concepts and critical thinking will be better if guided by activities in LKPD (Rizkika et al., 2022).

One effort that can be done is to design a student worksheet (LKPD). LKPD is a collection of sheets containing material based on basic competencies (KD), summaries, and activities that students will carry out (Pranomo et al., 2021; Rizalini & Sofyan, 2018; Satura et al., 2021). Student worksheets are sheets that contain activities that can foster curiosity in students, high-level thinking skills and skills. This LKPD serves as a guide in completing a task based on the steps involved in learning activities and facilitates educator activities so that interaction is achieved efficient between educators and students (Anggraini et al., 2017; Mustika & Susanti, 2020; Nadifatinisa & Sari, 2021). LKPD learning tools are a tool that really helps and facilitates learning process becomes the learning process becomes more effective between students and teachers and can increase student activity and achievement (Rahmawati & Wulandari, 2020). The steps that need to be taken in preparing Student Activity Sheets (LKPD) are analyzing the curriculum, compiling LKS needs maps, determining LKPD titles such as formulating basic competencies (KD), determining assessment tools, compiling material, compiling the structure of LKPD (Anita et al., 2021). LKPD also presents an interaction from teacher to student for students to work on individual learning activities, with practice and applying learning objectives (Lestari et al., 2018; Vivi Puspita & Dewi, 2021). LKPD can function as a guide for students to discover the concepts being studied, so that learning is constructive (Noprinda & Soleh, 2019). The use of LKPD in learning activities will be able to activate students, allow students to study independently according to their abilities and interests, stimulate learning activities and provide variations to learning activities so that students do not get bored easily (Eliati, 2020; Nurliawaty et al., 2017; Puspita & Dewi, 2021). It is important for teachers to create worksheets capable increase students' critical and creative thinking in order to be able to apply skills in the 21st century.

The development of LKPD aims to enable students to learn a design or teaching material independently or in groups and provide facilities for students to find concepts from a material through activities experienced by students directly (Mardita et al., 2022; Sapitri et al., 2022; Vadilla, 2022). LKPD has the advantage of making it easy to carry out teaching in accordance with the methods and material that will be taught by the teacher (Sapitri et al., 2022; Silvia & Simatupang, 2020). Looking at previous research, many LKS currently do not meet the requirements of the 2013 curriculum, but only contain material that is not yet detailed and unable to stimulate critical thinking (Firdaus & Wilujeng, 2018). Learning using LKPD effectively improves learning outcomes, knowledge, attitudes and skills of students (Pribadi et al., 2021; Vivi Puspita & Dewi, 2021; Vadilla, 2022). STEM-based LKPD can effectively improve students' KBK. Much research has been done on the development of STEM-based worksheets. Therefore, this study aims to develop a STEM-based LKPD in improving students' critical thinking skills on ecosystem material for class X.

2. METHOD

Development of teaching materials used is modifying the 4D model by Thiagarajan which consists of four stages namely: define, design and develop, and disseminate. The test subjects in this study

were 1 media expert and 1 material expert. After the LKPD was assessed by experts, the LKPD was then tried out on class X students on a limited scale, namely 22 students who were grouped into several groups. Collecting data with the method of observation, interviews and questionnaires. Observations were made by analyzing learning activities during the biology learning process in class. Interviews are used for needs, teacher problems in carrying out learning. The questionnaire is used when assessing the practicality of LKPD.

Methods of data analysis using quantitative and descriptive qualitative methods. Quantitative method is data processing that is done by compiling data in the form of numbers or percentages. Qualitative analysis was obtained from compiling data in the form of words and sentences as well as conclusions. Qualitative analysis techniques were carried out by grouping qualitative data information assessed from the response, criticism and suggestions for improvement contained in questionnaires and interview results. Quantitative analysis is data processing which is carried out by compiling data in the form of numbers or percentages (Rai et al., 2021). Quantitative data analysis was used to process qualitative data from a questionnaire using the Guttman scale. The percentage of the validity questionnaire is obtained by comparing the scores obtained with the maximum score multiplied by 100%. The conclusion-making criteria used in the validity assessment use the conversion of achievement levels with a scale in Table 1.

Table 1 . Criteria validity

Percentage (%)	Criteria
80.00 – 100	Very valid
60.00 – 79.99	Valid
50.00 – 59.99	Pretty valid
00.00 – 49.99	Invalid

(Riduwan, 2003)

The percentage of the practicality questionnaire is obtained by compare the number of yes answers with the number questions multiplied by 100%. The conclusion-taking criteria used in the practicality assessment use the conversion of the achievement level with a scale that can be seen in the following table 2.

Table 2 . Criteria Guttman Scale Practicality

Percentage (%)	Criteria
81-100	Very practical
61-80	Practical
41-60	Enough practical
21-40	No practical
0 – 20	Absolutely not practical

(Riduwan, 2003)

3. RESULT AND DISCUSSION

Result

This development research produced a STEM-based student worksheet to improve critical thinking skills on ecosystem material. media and materials were assessed by media experts and material experts, practicality was calculated from teacher and student responses and effectiveness was assessed from pretest and posttest results. The questionnaire used to assess student and teacher responses has been validated by instrument experts. The research results were analyzed based on the 4D model development stages, namely define, design, development, disseminate.

At the define stage, an analysis of the results of observations and interviews is carried out. At the design stage, the process of preparing the material to be displayed is carried out. The next stage is development, namely the process of making LKPD learning media products with designs using Canva and Word. The LPPD that has been made is then tested for validity by media and material experts through filling out the questionnaire, 25 questions for material experts and 26 questions for media experts, indicating that LKPD is feasible to be tested with revisions. The validity obtained by validation tests by media experts is 92.3% with a very valid category, and material experts 91% with a very valid category. As for suggestions from media and material experts in the form of advice in written and oral form.

LKPD which has been revised according to media expert advice and material is then tested on 22 students who have been divided into several groups. Then all students filled out the response questionnaire given. The practicality obtained from the student response questionnaire was 99.24% which were categorized as very practical LKPD. In this trial, a pretest and posttest were also carried out to assess the effectiveness of the use of LKPD. The effectiveness of using LKPD obtained an N-Gain value of 0.92 with high criteria. This happens because students are more specific and correct in answering questions so that students get high posttest scores. The STEM-based LKPD products produced in this study in [Figure 1](#).

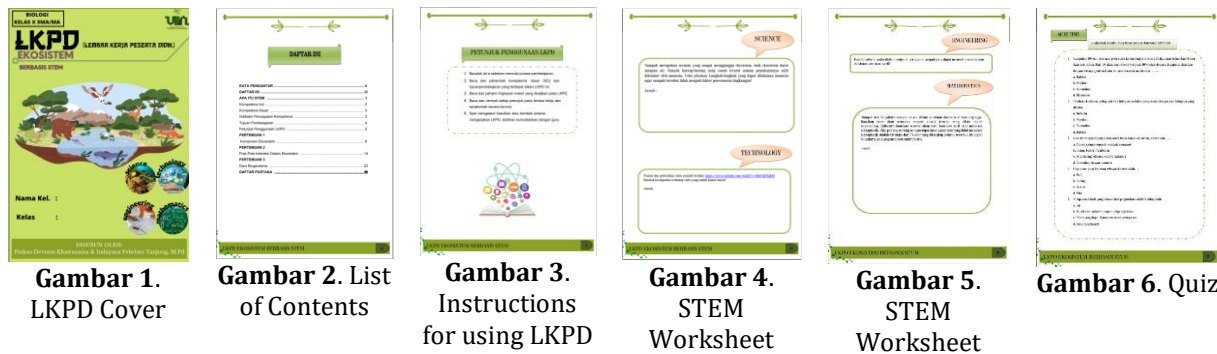


Figure 1. The STEM-based LKPD Products

Discussion

Presentation of material and supporting pictures have been adapted to SK, KD, indicators, and learning objectives to be achieved. Conformity between LKPD and SK, KD, Indicators, and learning objectives is an important component that supports the success of a media development ([Nurbaiti & Marbun, 2019](#)). The positive impression given by students to the developed LKPD shows that these students like the developed LKPD ([Ketut Sri Puji Wahyuni et al., 2021](#)). If students already like the LKPD, of course students will feel comfortable and more easily understand the material presented in it. In addition to receiving a positive response from STEM-based LKPD students, this was also effectively make student learning outcomes increase. STEM makes students' creativity and critical thinking develop with examples of problems in surrounding life ([Amin & Ibrahim, 2022](#)). The STEM learning method can train critical thinking skills effectively in cognitive abilities in the form of interpretation, analysis, evaluation, concluding, and explaining, as well as in affective dispositions, namely curious, truth-seeking and analytical ([Novidya & Kustijono, 2019](#)).

In line with Rizka's research which states STEM worksheets can increase students' critical thinking in material substance pressure material. ([Rizkika et al., 2022](#)). Other research results states that STEM-based worksheets in biology learning can improve students' critical thinking ([Simatupang et al., 2020](#)). STEAM is a learning content that uses five sciences, namely science, technology, engineering, art and mathematics, as a whole and related to one another as a pattern of problem-solving ([Başaran & Bay, 2022; Erol et al., 2022; Lindeman et al., 2014](#)). Applying the STEAM method results in students who take serious risks, engage in experiential learning, persist in problem-solving, embrace collaboration, and work through creative processes. The learning method of the STEAM approach is active learning, innovative and critical thinking in line with the STEAM learning concept (Science, Technology, Engineering, Art and Mathematics), the main concept is that practice is as important as theory. Students must use their hands and brains to learn ([Ahmad et al., 2021; Bayles et al., 2021; Hobri et al., 2021; Nkulikiyinka et al., 2020](#)).

If students only learn theory in the classroom, students cannot keep up with the dynamic changes in the world. The main feature of STEAM is the centre of learning different subjects. Students must practice the knowledge they learn. The application of STEAM-laden learning in its implementation is integrated into fields of knowledge based on applications in students' daily lives through a scientific approach that allows students to become creative, initiative and innovative individuals because STEAM content is learning with cross-disciplinary connections ([Kurnia & Nasrudin, 2022; Prameswari & Anik Lestarinigrum, 2020; I. Puspita & Raida, 2021](#)). STEM-based LKPD can effectively improve students' KBK. LKPD also presents interaction from the teacher to the student so that students work on learning activities individually, with practice and application of learning objectives. Previous research findings also state that LKPD guides students to discover the concepts being studied ([Muzayyanah et al., 2020; Puspita & Dewi, 2021](#)). Utilization of LKPD in learning activities will be able to activate students.

4. CONCLUSION

STEM-based worksheets developed using 4-D models have high validity. In addition, this STEM-based LKPD also received a positive response from students because it can significantly improve critical thinking skills in ecosystem material. STEM-based LKS can be used by teachers in learning activities so that learning activities become more effective and efficient.

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