

(RESEARCH ARTICLE)



Using ADDIE approach for development of student worksheet based STEM (Science, Technology, Engineering and Mathematic) to improve problem solving skills at state junior high school 3 in Ternate city Indonesia

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Abstract

This study aims to develop Student Worksheets based STEM teaching materials to improve problem-solving skills in conventional biotechnology materials, as well as to see the validity of the developed Student Worksheets based STEM. This research is a type of research and development or R&D, using the ADDIE approach (Analysis, Design, Development, Implementation, and Evaluation). The analysis step with analysis needs and curriculum carried out by researchers obtained information that the curriculum at Junior High school 3 in Ternate city was the 2013 curriculum by identifying Competency Standards (SK) and Basic Competence (KD) as indicators and learning objectives in conventional biotechnology materials to develop Student Worksheets based STEM teaching materials. The design step is carried out by compiling a draft or Student Worksheets based STEM learning framework, which contains a cover, introduction, table of contents, learning objectives, material descriptions, work procedures and bibliography. The product development stage that has been developed in the form of Student Worksheets based STEM teaching materials was validated by expert validators in the STEM field showing that Student Worksheets based STEM teaching materials were very feasible to be tested in the field with a percentage of 89%. The implementation phase was carried out by looking at the results of teacher and student responses in the form of a questionnaire with the results of evaluating teacher responses of 97.33% and 91.44% students towards Student Worksheets based STEM teaching materials on conventional biotechnology material in the field with very good categories. The evaluation stage for the development of Student Worksheets based STEM on learning outcomes in conventional biotechnology material is in the medium category with a percentage of 67.6%. from the results of this study it can be concluded that the development of Student Worksheets based STEM teaching materials on conventional biotechnology material can improve the problem solving skills of class IX students at Stated Junior High School 3 in Ternate city.

Keywords: ADDIE; Student worksheet; *STEM*; *Problem Solving*

1 Introduction

The development of technology (Science and Technology) is currently very important and is the key to facing future challenges. Various challenges that arise include improving the quality of life, equitable distribution of development and capacity building of human resources. The preparation of subjects is an effort to improve and improve the quality of education in Indonesia which is the demand for learning in the 2013 curriculum, it is hoped that it will have a process that provides opportunities for students to realize their potential [1].

Natural Sciences is a subject that stimulates students' ability to find relationships between natural and mathematical concepts. Science education as part of education plays an important role in the development of students who are scientifically literate, namely those who are able to think critically, creatively, logically and proactively in dealing with

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problems that arise as a result of the impact of developments in science and technology. Increase subject mastery by studying Science, Technology, Engineering and Mathematics (STEM) [2].

The development of worksheet based STEM (Science, Technology, Engineering, Mathematics)- maximizes student learning outcomes. This is done by combining indicators of Science (knowledge of nature), technology (products that facilitate human life), engineering (how to make products) and mathematics (forms of numbers and quantities) to meet students' needs, interests and skills [3]. The ability to solve problems (problem solving) is one of the abilities that students must have, namely students describe a phenomenon or situation as a component of the cause and effect of its supporters, and know the causal conditions of each phenomenon, so as to produce certain effects. Teachers are prepared to face the 21st century skills needed to enhance learning activities in the classroom. Problem solving skills require each student to have specific skills to solve problems in learning. Problem solving skills as one aspect of measuring increased student learning outcomes for quality learning. The process of getting students used to playing a direct role in learning activities will encourage children to be active and creative in solving problems in their own way [4].

Based on the results of surveys and interviews, on January 12 2021, several science teachers at Junior High school 3 in Ternate city found various problems during learning, especially in science learning class IX on the theme of Biotechnology and its development, there were no worksheet teaching materials (student worksheets) interesting and with character and the worksheet used is not oriented towards a multi-disciplinary approach, namely the concept of the material being taught that is in accordance with real world life based on technological developments. Worksheet can provide learning activities that are more well-planned and independent. This study aims to develop worksheet based STEM teaching materials to improve problem solving skills in conventional biotechnology material, as well as look at the validity of the developed worksheet

2 Material and methods

The method used in this study is the ADDIE research and development method. Based on Instructional design: The ADDIE approach ADDIE stages consist of five main stages namely Analyze, Design, Development, Implementation, and Evaluation [5]. This model is used by researchers to develop STEM-based worksheets with conventional biotechnology material for Class IX SMPN 3 Kota Ternate. The research sample was 20 students. The data collection technique used in this study was a questionnaire. The instrument used in this research is a questionnaire. The data analysis technique used in This development research is descriptive analysis qualitative, quantitative descriptive analysis of the validation percentage, questionnaire analysis and problem solving rubric [6].

3 Results

3.1 Description of the research data

The development of worksheet based STEM (Science, Technology, Engineering and Mathematics) teaching materials to improve students' problem solving skills in conventional biotechnology materials was developed using the ADDIE model consisting of analysis, design, development, implementation and evaluation. The needs and curriculum analysis stage carried out by researchers obtained information that the curriculum at Junior High School 3 in Ternate city was the 2013 curriculum by identifying Competency Standards (SK) and Basic Competence (KD) as the formulation of indicators and learning objectives on conventional biotechnology material to develop worksheet based STEM teaching materials. The Design Stage (design) is carried out by compiling a draft or worksheet based STEM learning framework, which contains a cover, introduction, table of contents, learning objectives, material description, work procedures and references.

Table 1 Preliminary design Development of STEM-based student worksheets

No	Description	information
1	Cover	Contains pictures, titles and identity of the author
2	introduction	Introduction to making worksheet
3	list of contents	Contains sub-chapters and a list of pages
4	Purpose	The goals to be achieved in learning
2	Material Description	Provide material from the theme developed
6	Work procedures	Fill in the work steps

The Development Stage of this worksheet teaching material is to produce products based on science, technology, engineering, and mathematics. The first stage in this worksheet is making nata de coco, the science is looking at the fermentation process of microorganism bacteria, technology indicators are the use of thermometers, balances, and erlemeyer, process engineering of finishing nata de coco into products, mathematica indicators calculating materials used in making nata de coco such as how many grams of material used. The second and third stages are the same in implementing STEM. The product that has been developed in the form of worksheet based STEM teaching materials was validated by 5 lecturers as expert validators in the STEM field showing that worksheet based STEM teaching materials were very feasible to be tested in the field with a percentage of 89%. The implementation stage (product testing) of the researchers looked at the teacher's responses to the student worksheets of 10 junior high school science teachers in several schools in the city of Ternate, and the student responses were carried out by 20 students. The results of teacher and student responses to teaching materials developed and implemented in the learning process in class have very good results with a percentage of teacher responses of 97.33% and student responses of 91.44%.

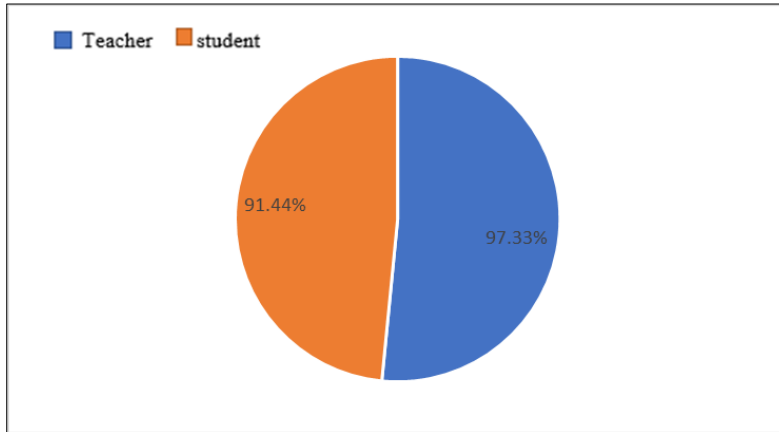


Figure 1 Results of Teacher and Student Responses

The Evaluation stage is carried out by analyzing student learning outcomes. Analysis of learning outcomes is divided into 2, namely the results of the pre test and post test. The implementation of the learning process was carried out in a class of 20 students, the results were seen before the development of teaching materials was applied and after the development of worksheet based STEM (Science, Technology, Engineering and Mathematics) teaching materials was implemented on conventional biotechnology material. The assessment instrument was made in the form of an essay with 5 questions. Completeness of learning outcomes can be seen from the average value of all students.

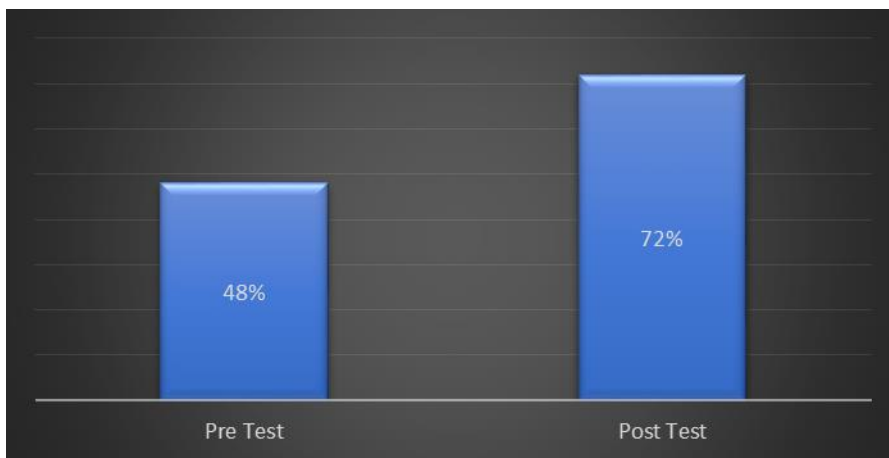


Figure 2 Student Learning Outcomes

Base from the picture above, student learning outcomes in the development of worksheet based STEM (Science, Technology, Engineering and Mathematics) teaching materials to improve student problem solving in conventional biotechnology material in class IX Junior High School 3 in Ternate city. Pre test results with a percentage of 49.60% in the low category, while the results of the Post Test with a high category at a percentage of 72.60%.

4 Discussions

The results of the develop Student Worksheets based STEM teaching materials to improve problem-solving skills in conventional biotechnology materials in this reseach is implementation of the 2013 curriculum is an effort to young people to have 21st century skills. The 2013 curriculum is learning-oriented The 21st century demands that students have 4C skills (Critical Thinking, Communication, Collaboration, Creativity). 21st century skills starting from the assumption that at this time humans has been in an environment that can not be separated of technology, information can be easily obtained with the rapid advancement of technology as well new ways of communicating and collaborating with other individuals [7]. This moment is technology, information and communication has growing rapidly and touching all fields life including education, in other words. This period has entered the digital era. Digital era impact such as easy access and utilize a variety of learning resources. in the era this digital should be a teacher as facilitator, motivator and inspiration must have use technology to find and Utilize learning resources and teaching materials for students [8]. Advances in technology, information and communication demands teachers as well students and other related parties to be able use or take advantage of technology in learning. Worksheet is one of the tools learning [9] Teachers can using worksheet as a support in the process learning to build optimal interactions between teachers and students in the learning process which will eventually result in an increase learning activities and student learning outcomes [10]. In the era of technology, information and communication which has grown rapidly teachers can take advantage of technology by packaging worksheet digitally or conventionally depending on conditions, digital worksheet can provide convenience for students in use or access worksheet without space limit and time. The advantages of worksheet based STEM in this study can train students in problem solving and critical thinking skills. Worksheet based STEAM developed can provide a view of the worksheet more interesting and can display feedback and scores quickly related to the work of students, so as to build the spirit of students in following the learning process. This is in line with the opinion of [11] that this LKPD allows students to get a response quickly or directly when finishing exercise. STEAM-based learning approach integrate multiple disciplines develop students' abilities in critical thinking, and creativity in problem solving so that this approach is in line with expectations and demands education in the 2013 curriculum [12]. This is relevant to several studies previous research, namely [13] regarding the development of worksheet based STEM for foster students' creative thinking skills. The research produced a product in the form of worksheet based STEM to grow skills students' creative thinking on the material Elasticity and Hooke's law. Research of [7] obtained the result that the Student Worksheet is based The developed STEAM is very suitable and feasible used in applying learning integrated thematic learning of the 2013 curriculum.

5 Conclusion

The results of this study provide the conclusion that:

- STEM (Science, Technology, Engineering and Mathematics) based LKPD teaching materials on conventional biotechnology materials that are developed are valid to use. This is evident from the results of the expert validation percentage of 91.44%. With a category very worthy of use.
- Analysis of teacher and student responses to STEM (Science, Technology, Engineering and Mathematics) based LKPD teaching materials on conventional biotechnology material with percentages above 97.33% and 91.44% in the very good category.
- Student learning outcomes in the pre-test and post-test have an increase in problem solving skills in conventional biotechnology material with the High category with a percentage of 67.60%.

So it was concluded that STEM (Science, Technology, Engineering and Mathematic) based worksheets can improve students' problem solving skills in conventional biotechnology material for class IX Junior High School 3in Ternate city.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest.

Statement of informed consent

All information in this paper has been approved by all parties concerned

Author's declaration

The authors hereby declare that the work presented in this article is original and that they will bear any liability for claims relating to the content of this article.

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