

Digital Worksheet Design Based on STEAM to Develop Students' Problem-Solving Skill

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Abstract

The low ability of students to solve problems in solving problems, especially math problems, needs to be a concern for all. This study aims to produce a STEAM-based digital worksheet design to develop students' problem-solving abilities. The research method used is R&D research with the ADDIE development model which is limited to the design stage. The design process of this student worksheet through two stages, namely the analysis (analyze) which includes (1) needs analysis, (2) analysis of student characteristics, (3) curriculum analysis aims to determine students' abilities, determine the limitations of the material, and whether or not to develop this worksheet. The second stage is the design (design), the researcher designs the digital worksheets after the worksheets compilation map is carried out, the preparation of the LKS content design, and also the collection of references. The result of this design is the design of the presentation of problem-solving problems in the form of problem themes that contain mathematical concepts with the stages of the problem-solving process using the STEAM approach aimed at meeting problem-solving indicators.

Keywords : Design, Digital Worksheet, STEAM, Problem Solving

INTRODUCTION

The 21st century or known as the knowledge age era is an era in which efforts to fulfill the needs of society are based on knowledge. Efforts to meet this need can be found in the fields of education, economy, human resource development, and industry (Wijaya et al., 2016). Changes in the pattern of human life in the 21st century as science and technology require people to have skills, one of which is learning and innovation skills so that they are able to participate in the development of the era in this 21st century. Based on the formulation of The Assessment and Teaching of 21st Century Skill (ATC21S) Project, the framework for thinking skills which is a necessary competency in the 21st century consists of problem-solving, creativity and innovation, critical thinking, and decision making (Haryono, 2017).

In Permendikbud No. 22 of 2016, it is explained that the purpose of learning mathematics is one of which is to encourage students to have problem-solving abilities through observing, asking, trying, reasoning, presenting, and creating (BSNP, 2016). Problem-solving is the ability to find an answer to solve a problem. Bransford and Stein (Himmatul, 2016) state that indicators in problem-solving ability are IDEAL problem solving which consists of (1) identifying problems, (2) defining objectives, (3) investigating problem-solving strategies, (4) implementing problem-solving strategies, (5) review and evaluate the impact of the effect of the determined problem-solving strategy. Students' problem-solving ability is also important because they are capable of high-level intellectual skills of students (Rosiani et al., 2019). In addition, it is able to hone thinking

skills, accustom students to have a diligent attitude, self-confidence, and curiosity when faced with situations in everyday life (Naimnule et al., 2018).

Based on the mathematics performance results obtained from PISA data, there is a decrease in the average score in the average ability of Indonesian students in learning mathematics from 386 in 2015 to 378.5 in 2018 (OECD, 2019). In addition, in the results of the analysis of the results of the national examination, the mean score of national examination scores for students, especially at the national, provincial, district/city levels, and education units for SMP / MTs levels are still below the average passing standard score of 55. The cause of the decline in the average score This average is due to the students' low problem-solving abilities (Fauziah et al., 2018). Based on the results of interviews at one of the state junior high schools in Sukabumi, there are still students who have not been able to meet several indicators of problem-solving, namely identifying problems and determining goals. Lack of habituation in solving analytical problems and a lack of student motivation in working on questions are other factors that cause students to have low problem-solving abilities.

One of the materials in mathematics that is still considered difficult by students is the circle, especially in the sub-material of the elements of circles, the area and circumference of the circle, and the relationship between the angles. The reason students find it difficult to solve problems related to circles, one of which is that students still cannot understand the problems that are presented in the questions. Another research that supports this is research by Hesty Narwani Siregar at SMP Negeri Pekanbaru, where there are still many students who have not been able to exceed the problem-solving indicators in this circle material (Siregar, 2019).

The learning approach that can be used as a means of developing problem-solving abilities in circle material is the STEAM approach. STEAM is an approach that emphasizes "Education that shapes students" in order to be able to motivate, encourage understanding of science and technology and foster literacy in the STEAM field based on science and technology and solving problems in the real world (Thuneberg et al., 2018). The concept of the STEAM approach is education based on scientific technology and problem-solving abilities in the real world, especially in mathematics and science (Kofac, 2018). The stages in the STEAM approach consist of (1) Context Presentation, namely understanding the problem, (2) Creative Design, namely creative problem-solving design, and (3) Emotional Touch, which is giving motivation in the form of evaluation and drawing conclusions (Kofac, 2018).

With technological developments and the increasing number of competencies that students need to have, a learning process is needed in accordance with this. One way to overcome this problem is by holding e-learning (Situmorang, 2016). E-learning has its own advantages, especially for students, namely with e-learning learning, students will find it easy to carry out the learning process anywhere and anytime (Wardani et al., 2018). However, in the implementation of e-learning learning, teaching materials are needed that are easy to access and also effective for e-learning. One of the teaching materials that are generally used in schools is LKS.

Trianto explained that the student worksheet (LKS) is a guide for students to carry out problem-solving activities (Prabawati & Herman, 2019). In general, the worksheets used in schools are still in the form of printed worksheets, and only contain a summary of the material, examples of questions and practice questions used as enrichment materials

to complement the material in the textbook (Nurmiwati, 2020). With the characteristics of these worksheets, it has not been effective in being able to develop students' skills, knowledge, and attitudes (Gazali, 2016).

One way to develop these teaching materials, especially to develop problem-solving skills in circular materials using the STEAM approach, is the development of digital worksheets. With the rapidly developing information technology and also the implementation of distance learning by e-learning, the development of digital worksheets is one of the strategies that teachers and students can use. In addition to containing a collection of activities or tasks that students can do with the internet and the sophistication of technological devices, students can carry out activities in the LKS wherever and whenever. Given the above background, this study aims to be able to produce digital worksheets with the STEAM approach to develop students' problem-solving abilities.

RESEARCH METHOD

The research method used in this research is the R&D development research method with the ADDIE model. The stages in the ADDIE research model consist of the analysis stage, the design stage, the development stage, the implementation stage, and the evaluation stage. In the discussion in this article, the research is limited only to the planning stage (design) which aims to produce designs from digital worksheets with the STEAM approach for developing students' mathematical problem-solving abilities. When this research was conducted in February until June 2020. Based on the results of a preliminary study conducted previously, the student's solving ability was still low, so this study used the research subjects of class VIII students of SMP Negeri 1 Sukaraja in the even semester of the 2019/2020 academic year.

In the analyze stage, the researcher carried out direct observation using unstructured interview techniques to mathematics subject teachers and students to obtain some data, namely (1) needs analysis, the data obtained from the results of this analysis were in the form of analyzing the availability of teaching materials in schools, analyzing the characteristics and circumstances of the student worksheets used (2) analyzing student characteristics, the data obtained from this analysis were data on students' problem-solving abilities (3) curriculum analysis, the aspects analyzed were Core Competencies, Basic Competencies, and Competency Achievement Indicators according to the circle material as a reference for the worksheets being developed. The instrument used in this stage is to use an interview guide. So that the data obtained from this analysis stage is qualitative data in the form of respondents' answers to the questions asked by the researcher. The next stage is the planning (design) of researchers to design digital worksheets after the preparation of the worksheets map, preparation of the content design of the worksheets, and also a collection of references.

RESULTS AND DISCUSSION

The process of developing STEAM-based digital student worksheets to develop students' problem-solving abilities consists of the analysis, design, development, implementation, and evaluation stages. However, the discussion in this article is limited to the analysis and design stages which aim to produce designs or designs from digital

worksheets with the STEAM approach to develop students' problem-solving abilities. Furthermore, it will be continued at the development, implementation, and evaluation stages. This worksheet was developed to help train students with low levels of ability in problem-solving skills specifically for math problems. So that when students are given problems related to mathematics students are able to solve these problems.

In previous research conducted by Haifaturrahmah, the results of the analysis showed that the teaching materials or worksheets used to study circle material at school were still in the form of printed worksheets or books. Then the LKS design is less attractive, lacks variation in design colors, material that is still general in nature, then, and the questions presented include structured questions (Khadijah et al., 2020). This is in accordance with the results of the needs analysis carried out by researchers where the LKS design is still less varied, then there is still no digital form of learning materials available. Based on the results of interviews conducted with mathematics subject teachers in schools, it is known that students' problem-solving abilities are still low, this is supported by research conducted previously by Fauziah (Fauziah et al., 2018).

The curriculum analysis carried out by researchers aims to identify the circle material used in schools. The curriculum used by schools uses the K-13 curriculum. Based on Permendikbud number 37 of 2018, it explains that the core competencies and basic competencies which are in accordance with the circle material based on these regulations are as follows:

Basic Competence in Circle Material

No	Core Competencies	Basic competencies
1	Appreciate and live up to the teachings of his religion	-
2	Appreciate and live honest behavior, discipline, responsibility, care (tolerance, mutual cooperation), courteous, self-confidence, in interacting effectively with the social and natural environment within the range of association and existence.	-
3	Understand and apply knowledge (factual, conceptual, and procedural) based on his curiosity about science, technology, art, culture related to visible phenomena and events	3.7. Describe the center angle, perimeter, arc length and area of the circle, and their relationship. 3.8. Describe tangents to outer and communion in two circles and how to paint them.
4	Processing, presenting, and reasoning in the realm of the concrete (using, parsing, arranging, modifying, and making) and the abstract realm (writing, reading, counting, drawing, and composing) are appropriate.	4.7. Solves problems related to the center angle, perimeter, arc length, and area of the circle and its relationship. 4.8. Solve problems related to the tangent of the outer community and the partnership in two circles.

(source: Kemendikbud, 2018)

there will be two sub-sciences that are different but have a relationship with the theme raised, these sub-sciences are the sub-sciences and mathematics.



Figure 2. Display Design of Main Themes of STEAM-Based Digital Worksheets to Develop Students' Problem Solving Ability



Figure 3. Examples of Presenting Problems in the Ain Dubai Theme in Science Sub Material.

In the sub-science that is presented in this LKS in the form of story questions with included pictures that are adjusted to the themes provided. An example is like the first theme in Figure 3. The topic that is the main theme of the Ain Dubai theme is about the giant Ferris wheel named Ain Dubai so that the questions presented are in the form of physics concepts found in Ain Dubai. This science problem is presented to help attract students' curiosity or interest in learning before solving math-related problems, as well as to provide new information to students for examples of applying math and science concepts in everyday life.

In general, the presentation of the questions contained in the worksheets is only in the form of examples of questions and questions that students must work on without determining the stages in each structured problem-solving (Khadijah et al., 2020). In accordance with the stages of the STEAM approach used, the presentation of this problem is divided into three stages. The first stage in presenting the problems in this LKS is understanding the problem (Context Presentation) which aims to meet the problem-

solving indicators in the IDEAL problem-solving model, namely knowing the problems presented and the objectives of the problem.

The sub-mathematics presented in this worksheet is presented in various ways, one example is in Figure 4. The questions presented are in the form of short field questions using the comic strip concept to describe the problems that will be solved by students on this theme. The mathematical concept carried out in this sub-mathematics is the concept of the arc length and also the area of the circle's circle

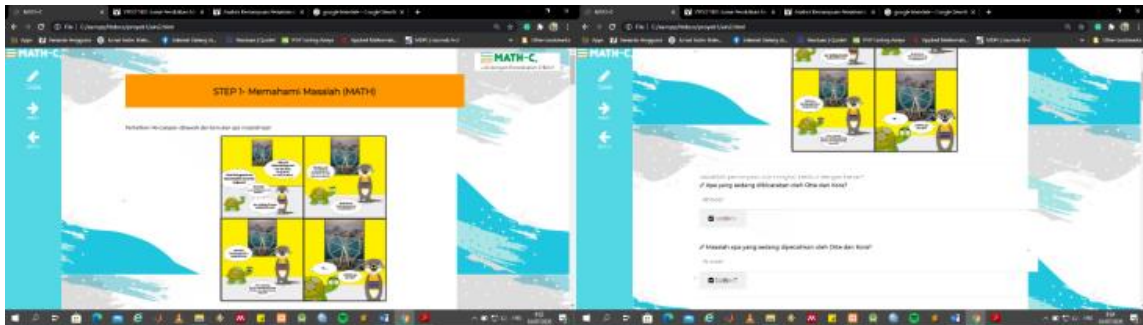


Figure 4. Examples of Presenting Problems in the Ain Dubai Theme Stage of Understanding the Problem (Mathematics)

Presentation of the problem-solving process in mathematical material is usually seen in working on a problem. There is no clear division regarding the structured problem-solving process (Sholekah et al., 2017). The second stage of presenting the problem according to the STEAM stage is the problem-solving design (Creative Design). This stage aims to meet the problem-solving indicators in the IDEAL problem-solving model, namely investigating problem-solving strategies and also implementing problem-solving strategies according to the results obtained in the first stage. In figure 5, the questions posed at this stage are in the form of short questions designed by applying the relationships of the concepts from the circle related to the derivation of the formula that can be used to solve problems according to the results of the first stage.



Figure 5. Problem Solving Design Process Presentation Design (Mathematics)

The last process contained in a worksheet is the evaluation process. The existence of this evaluation fulfills the criteria for a good indicator in the development of an LKS (Sagita, 2016). The final stage in the worksheets using the STEAM approach is emotional touch (Emotional Touch) which contains the evaluation of problem-solving results. This stage is still connected with the previous stages. The purpose of this stage is to meet the last indicator in student problem-solving in the IDEAL problem-solving model, namely reviewing and evaluating the impact of the effect of the specified problem-solving strategy. The design of the presentation of this stage is in the form of evaluation questions

to find out how students understand the concepts that have been used in the first and second stages then students are directed to determine what conclusions are obtained from the problems that have been solved.



Figure 6. Display Design of the Ain Dubai Theme Emotional Touch Stage (Mathematics)

CONCLUSION

In this study, the design of teaching material, namely digital student worksheets with the STEAM approach, is used to develop students' problem-solving abilities that can be used by grade VIII students who at the next stage will enter the development stage which includes the stage of being validated by a validator (expert), implementation (implementation), and evaluation (evaluation).

The stages of the LKS development process are the analysis stage which includes (1) needs analysis, (2) student characteristic analysis, (3) curriculum analysis. also whether or not the development of this LKS is necessary. The next stage is planning (design) researchers design digital worksheets after a map of the preparation of worksheets is carried out, preparation of the content design of the worksheets, and also a collection of references.

The presentation of questions or problems in this worksheet is in the form of a problem packaged in a theme that contains one application of mathematical concepts in everyday life. From this concept, the problem is divided into two parts, namely the sub-science, which aims to attract students' interest and curiosity in continuing learning before solving problems in the mathematics sub-mathematics and the second part is the mathematics sub.

In the presentation of questions in sub-mathematics, the presentation of the problem is presented in a variety of ways either using comic strips, stories, or image analysis. In the problem-solving process, it is divided into three stages according to the STEAM approach used, these stages consist of the stage of understanding the problem (Context Presentation) which aims to meet the problem-solving indicators of the IDEAL problem-solving model, namely understanding problems and determining problem objectives, the second stage designs. Problem-solving (Creative Design) which aims to investigate problem-solving strategies and implement problem-solving strategies. The final stage of this stage is evaluation and conclusion (Emotional Touch) which aims to review and evaluate the impact of the effect of the specified problem-solving strategy. The

types of questions presented are in the form of short questionnaires containing questions based on the objectives of each stage presented in the LKS. It is hoped that there will be more research on the development of STEAM-based teaching materials and it is hoped that there will be further research related to STEAM-based development.

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