STEM-based worksheet on digestive system material to improve students’ creative thinking skills

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ABSTRACT

One of the problems that often occur in the learning process is the low level of student's creative thinking which can be seen from four aspects, namely fluency, flexibility, originality, and elaboration. Efforts that can be made to improve students' creative thinking abilities include developing learning tools based on the STEM learning approach. This study aims to produce biology worksheet based on STEM approaches in digestive system material that is valid, practical, and effective in improving students' creative thinking skills. The type of research carried out is research and development by using the 4D model (Define, Design, Develop and Disseminate). The instrument used was validation sheets, questionnaire, and test. In this study, the average score of students' creative thinking ability was 85.30 with a completeness percentage of 87.5%. Based on the results obtained, it can be concluded that the STEM-based worksheet in digestive system material is declared valid and feasible for use and can improve students' creative thinking.

Keywords: creative thinking, students' worksheet, STEM

INTRODUCTION

One of the problems faced in the world of education is the problem of learning processes. In the learning process, students are less encouraged to develop creative thinking skills. In general, in each learning activity, students are encouraged to improve their ability to memorize information and are forced to remember information without being required to understand the information they remember to relate it to everyday life (Sanjaya, 2007). The problem that occurs at this time is the low ability to think in students as evidenced by students who are still confused in working on questions, grouping elements in questions, steps to be taken in working on questions, and so on (Marlani, 2015). Based on the results of interviews with the biology teacher at MAS YASPI Labuhan Deli, some information was obtained from the results of students’ answers. When given evaluations, there were problems faced by students. These problems include: 1) students tend not to answer when the teacher gives questions, so this does not show the fluency of students in expressing their ideas, 2) in answering questions or problems, students only give answers according to what the teacher exemplifies. The ability of students to find alternative answers to problems is still lacking, so students do not appear to be flexible in thinking about alternative answers that vary, 3) students tend to still memorize or imitate what is given by the teacher so that students do not seem to think original in solving a problem, 4) students have not been able to explain in detail or coherently from a problem given by the teacher so that students' elaborating skills have not appeared in solving a problem. From these problems, the researcher suspects that students’ ability to think creatively in biology learning is still low (Nasution, 2019).

Rahmawati & Astuti (2017) revealed that in general, the ability of students' creative thinking in cognitive aspects both for science and mathematics is still relatively low. Students only master routine questions and simple computations. This reinforces the fact that current learning activities are not so focused on
improving students' abilities and creative thinking skills. Most students are accustomed to memorizing the material that has been given by the teacher so that students are only able to solve the same problem as exemplified by the teacher. This causes students to lack confidence, confused when faced with non-routine real problem situations, and students are not afraid to do something new (Sutrimo, 2019).

The 2013 curriculum can be applied and integrated with a particular approach such as the Science, Technology, Engineering, and Mathematics (STEM) approach to support the development of these skills. Science, Technology, Engineering, and Mathematics (STEM) is an approach formed based on a combination of several disciplines, namely Science, technology, engineering, and mathematics. Collaboration in the learning process, STEM will help students to collect and analyze and solve problems that occur and be able to understand the relationship between a problem and other problems (Handayani, 2014). This means that through the STEM approach, students are not just memorizing concepts, but rather how students understand and understand scientific concepts and their relation to everyday life. In addition to using the right learning approach, the use of teaching materials must also be appropriate so that students' thinking skills can be trained. Teaching materials play an important role in ensuring the effectiveness of teaching and learning activities (Kaymakci, 2012).

Efforts are being made to get graduates who can relate the knowledge gained to real life in the world of education, one of which is using an approach. To achieve learning success, in addition to using the right learning approach, the use of teaching materials must also be appropriate so that the level of student's creative thinking can increase. Teaching materials play an important role in ensuring the effectiveness of teaching and learning activities.

The STEM approach needs to be integrated into learning tools, one of which is worksheet. STEM-based worksheet is worksheet whose learning method is in the form of interdisciplinary learning where students combine science, mathematics, technology, and engineering in one unit to train students' creative thinking abilities (Pusfarini et al., 2016). Students' worksheet can be used to improve students' creative thinking skills which involve hands-on activities such as investigations and thinking activities such as analyzing data from investigation results. Moreover, this research aims to develop STEM-based worksheet to improve students' creative thinking skills (Mukti, 2018).

**METHOD**

The research was conducted in March-September 2023 and carried out at MAS YASPI Labuhan Deli. The subjects in this study were one biology lecturer expert in material, one biology lecturer media expert, one design expert lecturer, one biology teacher, and as many as 24 grade X students in MAS YASPI Labuhan Deli. The object of this research is worksheet adapted to the STEM approach which aims to foster students' creative thinking skills on digestive system material.

This type of research is research and development to improve students' creative thinking skills by using 4D model. Ibrahim (2010) said that the 4D development research procedure includes the define, design, developing, and dissemination stage. The define stage includes analysis of student needs and analysis of worksheet's material. The design stage includes determining the worksheet title and determining the initial worksheet design which includes study guides, competencies to be achieved, supporting information, media selection, and test preparation. The development stage includes development testing which is tested directly by learning design expert, material expert, and media expert. The dissemination stage in which the STEM-based worksheet was directly tested on students of MAS YASPI Labuhan Deli class X-MIPA.

The research instruments used were validation sheets of some experts in instructional design, material, media, questionnaire sheets of teacher and students response, and test for the
developed worksheet. The instructional design expert validation sheet contains several assessment criteria, namely component presentation, STEM components, and worksheet content design. The media expert validation sheet contains the feasibility of presenting the material, the STEM components in the worksheet, and the use of language. The teacher's response questionnaire sheet for the product contains the appearance of the worksheet, content feasibility, STEM, and language components. The student response questionnaire contains individual field tests, small group tests, and limited group tests. The three indicators that students responded to were the appearance, the presentation, and the learning activities in the worksheet. The data obtained in this study are quantitative and qualitative. Quantitative data was obtained in the form of assessment scores by instructional design experts, material experts, media experts, teacher responses, and student responses. Meanwhile, the qualitative data obtained was in the form of responses and suggestions given by the validator regarding STEM-based worksheet which has been developed.

Table 1. Revised results from instructional design experts on worksheet

<table>
<thead>
<tr>
<th>Suggestion</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Added calculation method for math content</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed the language layout of the subject matter</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION

At the define stage, interviews and observations were conducted with teachers in the field of biology studies. Some information was obtained that the existing worksheet was not able to present the main objectives in learning such as KI-KD, learning indicators, and learning steps. The worksheet used at school in its preparation also does not meet the requirements for good and correct worksheet, the worksheet used is still unattractive and relatively simple, only contains cognitive questions, does not encourage students to generate opinions or new ideas during the learning process on the material related to digestive system, so it does not foster the ability to think creatively in students. At the design stage, make the worksheet cover, introductory words, core competencies, and basic competencies in digestive system material. At the development stage, product validation was carried out through a series of learning design experts and media experts.
Technology and engineering activities are carried out separately

Fixed the color of the text on additional info to make it easier to read

From the results of data analysis on the use of worksheets with the STEM approach on digestive system material that has been designed in limited class groups, an average score of 85.30 is obtained with a total percentage of completeness of 87.5%. Data on student learning outcomes after using worksheet with the STEM approach on digestive system material.

Table 2. Categorization of student learning outcomes

<table>
<thead>
<tr>
<th>Creative Thinking Results</th>
<th>Category</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-100</td>
<td>Very creative</td>
<td>5</td>
<td>20.8%</td>
</tr>
<tr>
<td>80-89</td>
<td>Creative</td>
<td>15</td>
<td>62.5%</td>
</tr>
<tr>
<td>70-79</td>
<td>Enough Creative</td>
<td>4</td>
<td>16.7%</td>
</tr>
<tr>
<td>60-69</td>
<td>Less creative</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0-59</td>
<td>Not creative</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 3. Interpretation of the final score of the ability to think creatively on the use of worksheet

<table>
<thead>
<tr>
<th>Creative Thinking Results</th>
<th>Category</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>81-100</td>
<td>Very creative</td>
<td>20</td>
<td>83.3%</td>
</tr>
<tr>
<td>61-80</td>
<td>Creative</td>
<td>4</td>
<td>16.7%</td>
</tr>
<tr>
<td>41-60</td>
<td>Enough Creative</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>20-40</td>
<td>Less creative</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0-20</td>
<td>Not creative</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 4. Percentage of completeness of class learning outcomes

<table>
<thead>
<tr>
<th>Creative Thinking Results</th>
<th>Creative</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-74</td>
<td>Not completed</td>
<td>3</td>
<td>12.5%</td>
</tr>
<tr>
<td>75-90</td>
<td>Completed</td>
<td>21</td>
<td>87.5%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>
Data on the categorization of student learning outcomes can be seen in Table 2, data on the interpretation of the final score of the creative thinking ability test on the use of worksheet can be seen in Table 3, and data on the percentage of achievement of the STEM approach in Table 4.

Based on data analysis from the results of the limited field group testing conducted at MAS YASPI Labuhan Deli on 24 students of grade 11, it can be seen that the number of students who completed their study results was 21 students with a percentage of 87.5% with the scores in the "very creative" and "creative" categories. Students whose assessment results did not complete were 3 students with a percentage of 12.5% and scores in the "medium" category, where students who did not complete their learning outcomes were because there were several assignments that were not done on worksheet, and were less active in group work so that after adding up the total the value from the start of the initial activity to the end gets a score below the minimum criteria. Based on the table it can be seen that students' creative thinking skills are in the "creative" category with a total of 4 students, in the "very creative" category with a total of 20 students, and no students are in the "quite creative", "less creative" and "not creative" categories. Therefore, the average score of student's creative thinking skills is 85.30 with a completeness percentage of 87.5%. Thus, it can be concluded according to the theory that increasing creative thinking is said to be successful if in the class there are at least 85% of students who have completed their studies or achieved a predetermined mastery grade, and the data obtained is 87.5%, it can be concluded that the developed learning worksheet proved successful so that the worksheet tested on a limited group was significantly effective in fostering students' creative thinking abilities.

The final product of the worksheet developed is following a good structure according to the Ministry of National Education in Velda (2017), a good worksheet structure includes titles, study instructions, competencies achieved, supporting information, tasks, and work steps. The validity of the developed worksheet can be tested by obtaining opinions from experts, namely material experts, media experts, and instructional design experts. Worksheet is said to be valid if the results are following the criteria, meaning that it has parallels between the results and the predetermined criteria.

Material experts stated that worksheet with the STEM approach to foster students' creative thinking skills in digestive system material was "very feasible" with a total score of 51 with a percentage of 89.5%. Based on the results obtained, it can be concluded that the material in the worksheet is following the 2013 curriculum KI and KD and already contains STEM.

Good language use should adhere to Indonesian Spelling (EYD) and Indonesian Dictionary (KBBI) rules, use standard language, and do not interpret double meanings in sentences in worksheet. In Hidayah (2016), the use of language is the process of selecting linguistic forms to express meaning, and language is a means of forming human thinking abilities, therefore the use of language must be simple and easy to understand. It is supported by Widjanti (2008) who states that worksheet must be written in a language that is simple, clear, and easy for students to understand. Therefore, when students use the worksheet, students will understand it more quickly and will not ask the educator too often.

Learning assessment of worksheet with the STEM approach was carried out by two expert validators, the assessment aspects consist of content feasibility, STEM components, and language use. Based on the results obtained, the two media experts stated that worksheet with the STEM approach to foster students' creative thinking skills in the "very eligible" with a total score of 44 and 38 respectively with a percentage of 93% and 83.4%. Based on the results obtained, it can be concluded that the learning components in worksheet are STEM-based.

This can be seen from the contents of worksheet which contain STEM learning concepts or steps starting from science as a scientific
method, technology as technology utilization, engineering as product design, and mathematics as data analysis or use of formulas in the data processing containing indicators of creative thinking as well as the main material on the digestive system. Media experts analyze and validate the worksheet products that have been designed before testing their feasibility for students to prevent unwanted distractions or problems in the learning process. According to Handayani (2014) teaching using STEM will help students to collect, analyze and solve problems that occur and be able to understand the relationship between a problem and other problems. It is supported by Fathoni (2020), which states that STEM learning is a learning process of solving a problem with systematic research (mathematics), by observing and testing (science), using the field of knowledge that is mastered (technique), and utilizing available facilities (technology).

The design assessment of worksheet with the STEM approach is carried out by two design experts who are experts in their fields, the assessment aspects consist of Component Presentation, STEM Components, and Graphics. Based on the results obtained, from each design expert, validator 1 stated that worksheet with the STEM approach to foster students' creative thinking skills in the digestive system material was "very feasible" with a total score of 47 and a percentage of 84%. Validator 2 stated that worksheet with the STEM approach to foster students' creative thinking skills on "decent" digestive system material with a total score of 36 and a percentage of 75.7%. The presentation of the worksheet design on the digestive system material is already interesting. The worksheet component is good, which means that the cover is suitable for conveying the concept and content of the worksheet, and the images displayed on the worksheet are clear and able to attract students' interest in reading (Alghafri, et al., 2014). The performance of worksheet in general is good and creative. The size of the letters in the title and content is good so that the worksheet is easy for students to read. The performance of worksheet in general is good and creative. This is supported by research carried out by Pratama & Siregar (2019), which states that proportional (clear and precise) writing and the size of titles and sub-headings are important because students become clearer in understanding the part of the material being studied.

Assessment of worksheet was carried out by Mrs. Gustina Sumiani, SP. The assessment aspects consist of worksheet appearance, content feasibility, STEM components, and language. The results of the teacher's assessment of worksheet got a score of 57 with a percentage of 96.6% with the criteria "very eligible". The results of the assessment by the subject teacher were that the material in the worksheet was packaged simply, the questions and instructions for working on the questions used language that was easy to understand, and the color of the sentences in the supporting information was corrected so that students read it more easily, and provided more space for students write or fill in the questions given. Therefore, the worksheet that has been developed can be used and can help teachers in the learning process. This is supported by the opinion of Nugraheny (2018), who said that the use of appropriate worksheet would greatly assist teachers and students in carrying out activities in the learning process. According to Toharudin in Nugraheny (2018), the use of worksheet can also foster students' interest in learning through discussion and implementation of work steps on worksheet. Based on Marsa (2016), worksheet can help and facilitate teachers in learning activities so that effective interactions can be formed between students and teachers, to increase student activity in improving learning achievement.

The assessment aspect of the worksheet was carried out by 10 students, the results of the assessment of the STEM-based worksheet on the digestive system material to foster students' creative thinking obtained a percentage of 95% with the criteria "Easy" which means it can be
used in the learning process (Rahmatillah, 2017). Students provide responses and suggestions on worksheet, from the suggestions and responses of students it can be seen whether the available worksheet can help students understand the material and foster students' creative thinking skills. Students gave responses that the instructions and work steps on worksheet were easy to understand, worksheet could help students to understand the material, as well as increase students’ curiosity about biology subjects. Based on the results of the assessment, all students stated that worksheet could foster creative thinking. Suggestions from students for worksheet to provide more columns to answer questions that are already available, so that students can answer better. According to Wirdhani (2019), worksheet should be designed and designed according to the subject matter and learning objectives. Worksheet needs to be designed as attractive as possible to stimulate students to be interested in learning. The answer column must be adjusted to the worksheet. With the worksheet students can be trained to work on existing questions and exercises.

The testing of using worksheet in a limited field was carried out in class 11 MIA-1 with a total of 24 students. Testing the use of worksheet is an important part of development research. The worksheet product testing aims to find out whether STEM-based worksheet has achieved learning goals and objectives or not. Assessment of material on worksheet with the STEM approach uses an assessment aspect consisting of the feasibility of presenting material, STEM components, and use of language.

Based on Table 4, it can be seen that from a total of 24 students, 21 students were successful in answering STEM-based questions with a percentage of 87.5%. Piyah (2019) states that learning using STEM-based worksheet can increase student learning motivation compared to using conventional worksheet, and increased motivation also affects student learning activities. This is in line with Parwati’s et al (2015) say that STEM learning can build creativity, scientific literacy, and problem-solving skills needed to face the 21st century. Another study conducted by Sambada (2012) also stated that the higher the level of creativity the higher the level of ability to solve problems in learning. The use of the STEM approach in worksheet can help students grow their creative thinking skills. According to Abdurrahman in Surya (2018), STEM can make students active, collaborative, and skilled, and learning can be meaningful. The application of the STEM approach in worksheet indirectly requires teachers and students to think creatively. Student activities in solving problems characterize learning that fosters students' creative thinking abilities.

CONCLUSION

This study produced STEM-based worksheet on digestive system material to foster students’ creative thinking skills with a material expert assessment result of 89.5% with the criteria "very eligible". Assessments from media experts got respectively 93% and 83.4% with the criteria of "very eligible". Ratings from design experts get ratings of 84% and 75.7% respectively. Then the assessment of 96.6% of teachers in the field of biology studies. Assessment of 95% of students with each assessment gets the criteria "decent and very feasible" and worksheet is easy for students to understand. The worksheet is based on the STEM approach which is designed to effectively foster students' creative thinking abilities with an assessment percentage of 83.3% with the "very high" criterion. Students get an average score of 85.30, and completeness of 87.5%.

The limitation of this study is that students are not used to using STEM-based worksheet so an initial introduction to students is needed. The developed worksheet can be used as a reference in the development of teaching materials by teachers to see students' creative thinking abilities in the cognitive domain. Suggestions that can be given for further research are to assess the results of creative thinking on the description questions listed in the worksheet, it is best to
make a detailed answer rubric to make it easier for researchers to guide the assessment. Making questions should pay attention to the number of questions for each indicator of creative thinking, to obtain a proportional composition of questions.

REFERENCES


