



Development of STEM-Based E-LKPD on Senses System Material to Improve Creative Thinking Ability

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Abstract: Creative thinking is an important problem in learning. One of the learning approaches that can be used to improve creative thinking skills is the STEM learning approach. This is effective if it is supported by teaching materials in the form of E-LKPD. This study aims to determine the development of STEM-based E-LKPD learning media on human sensory material to improve the creative thinking skills of class XI students at SMA/MA. The method used in this study uses the Research and Development (R&D) method with a 4D model. The results of data analysis were carried out using a validation sheet in the form of a response questionnaire. The validation results from media experts get a percentage of 80% in a very valid category, from material experts get a percentage of 97% in a very valid category, from question instrument experts get a percentage of 88% in a very valid category and from questionnaire experts get a percentage of 100% with very valid category. The practicality test obtained a percentage score of 100% from school teachers in the very practical category and 98.2% from students in the very practical category. The N-Gain results in this study obtained a value of 0.6 in the moderate category. The conclusion of this study states that the STEM-based electronic Student Worksheet (e-LKPD) is very valid, practical and effective.

Keywords: Creative thinking; E-LKPD; STEM; 4D

Introduction

Creative thinking is an activity of thinking in seeking and finding new ideas in solving problems that are unique, flexible, and aesthetic. Creative thinking is an activity of thinking continuously to achieve goals by creating various things that are creative (Amidi & Zahid, 2016). The implementation of the 2013 curriculum is a reference for educators in implementing learning processes that can hone students' thinking skills. So far, the learning process of students is more emphasized by rote memorization to find out information on subject matter at school. Evaluation of student learning is also in the form of tests that still favor cognitive aspects. If students continue to be expected to memorize subject matter, then other subject matter will be easily forgotten because students will try to memorize the next lesson again (Sari et al., 2019).

The development of creative thinking skills can familiarize and train students to find answers to problems and phenomena in learning materials.

Students will try to know and remember and find creative solutions when learning. Students are also expected to be able to create new things from some of the knowledge learned. According to Rahmatillah et al. (2023), indicators of creative thinking are fluency, flexibility, originality, and elaboration. Fluency is the individual's ability to convey as many ideas as possible correctly and clearly. Flexibility is the ability of individuals to find various ideas from various aspects. Originality is an individual's ability to produce ideas or ideas that are unique and different from other sources. Detail is the ability of individuals who produce ideas in describing the influencing factors and adding an idea so that the idea is more valuable.

The 2011 TIMMS results released that the level of students' creative thinking skills in Indonesia is still relatively low (Buyung, 2021). As can be seen from the results of The 2015 Global Creativity Index, Indonesia is ranked 115th out of 139 countries (Shoit & Masrukan, 2021). Only 2% of Indonesian students are able to work on questions in the high and advanced categories. High

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and advanced performance is thinking abilities that place themselves at the C6 cognitive level in Bloom's Taxonomy which is none other than Create or the ability to think creatively. To improve students' low creative thinking skills, efforts can be made with the STEM approach. This aims to realize active learning and in accordance with the 2013 Curriculum. Currently, the STEM approach in Indonesia is still rarely implemented. STEM-based education was first used by the National Science Foundation (NSF) USA in 1990 to refer to public regulations related to improving the quality and competitiveness of the USA in the STEM field (Hasanah et al., 2021).

STEM is a learning approach that connects four fields, namely science, technology, engineering and mathematics into a holistic whole (Jauhariyyah et al., 2017). The goals of STEM in the world of education are in line with the demands of 21st century education, namely that students have scientific and technological literacy skills that can be seen from reading, writing, observing, performing science skills, and being able to develop the competencies they already have to apply them in dealing with problems in everyday life which related to STEM fields. Along with the development of the times where the demands of the 21st century that education must be linked to science, technology, engineering and mathematics, STEM-based LKPD is indispensable with the aim of increasing students' creative thinking abilities (Mahjatia et al., 2021).

STEM has a number of advantages for students, including: 1) making collaboration, discourse, and student sensitivity a hope, 2) encouraging risk-taking by building a learning environment that seeks various solutions for every problem, 3) is expected to instill students' hearts with problems and challenges the real world will foster empathy and reduce fighting, 4) engage students through closed and open exploration and guided inquiry, 5) actively incorporate engineering design processes, 6) use content integration to help students understand the relationship between mathematics and science, 7) recognize and Appreciate failure as part of the process.

The hope is that the STEM approach can bring up innovative, creative and fun learning models so that learning can explore students' potential, one of which is by increasing students' creative thinking abilities. In addition, students can understand more deeply the importance of mathematics for science, engineering and technological development. And vice versa, STEM is currently a learning alternative that can build generations that are able to face the 21st century. The integrated application of STEM requires teachers and students to think creatively. In addition to using an integrative approach, teachers are required to be creative in developing teaching materials. Teaching materials used by teachers greatly affect student learning

outcomes. In science learning, students are guided by the teacher to actively find their own understanding related to learning material. An approach that emphasizes creative thinking requires a variety of learning tools to produce an environment that can foster students' creative thinking. Therefore a teaching material is needed to support the learning process, one of which is the Student Worksheet (LKPD) (Aldila et al., 2017).

Student Worksheets (LKPD) are worksheets containing assignments done by students, containing instructions, steps to complete a task in the form of theory and practice (Permanasari, 2016). Student Worksheets (LKPD) 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 (Aldila et al., 2017). However, the use of LKPD has not been widely used in schools. Based on observations made at MAN 1 Deli Serdang, that subject teachers usually use media in the form of companion books obtained from public publishers. The only companion book contains a summary of material and practice questions which are generally in the form of multiple choices (multiple choices) or essay, where the book is not appropriate with the 2013 curriculum learning activities that promote creativity and innovation skills. The use of LKPD in learning is also very rarely used by teachers in the teaching and learning process. The LKPD used in schools also has content that places more emphasis on questions, filling out questions without understanding how the learning material is in the LKPD, the cycles experienced by students in solving the answers to questions which are still in the form of exercises that do not foster students to be creative so that it causes these students to tend to feel tired during the educational experience.

The application of the STEM approach to biology lessons is indispensable. When viewed from some of the existing material in biology lessons emphasizes students' understanding of direct learning experience (Siregar et al., 2021; Wardana & Adlini, 2022). Processes that occur in nature and the surrounding environment can improve students' creative thinking skills in answering problems and phenomena associated with real life (Wahyuni et al., 2022). Students can use STEM-based LKPD with their creativity to understand and find solutions from applied learning (Mahjatia et al., 2021). Efforts that can be made to improve the ability to think creatively using the STEM approach. The use of the STEM approach can be implemented in teacher teaching materials in the form of worksheets. STEM-based worksheets can be used to improve students' creative thinking skills (Aldila et al., 2017; Rahman, 2018; Anggraini & Simatupang, 2020). This study aims to develop STEM-based E-LKPD on sensory systems

material which demonstrates its validity, practicality, and effectiveness in improving students' creative thinking abilities.

Method

This research method was carried out using Research and Development to develop teaching materials in the form of STEM-based Student Activity Sheets (LKPD) to improve students' creative thinking skills on sensory systems. The development model used is the development of the 4D model worksheet (Four-D) which is applied to 4D by Thiagarajan et al. (1974) namely, define, design, develop, and disseminate. Define stage: this stage results from the observation process that has been carried out on the learning process in schools. Design Stage: the purpose of this stage is to make LKPD, which consists of 3 stages namely, compiling tests, choosing media, preparing learning objectives, and drafting LKPD. The design of LKPD was carried out based on the STEM learning process. The material used is the Human Sense System. Develop stage: the purpose of this stage is to develop LKPD with valid, practical, effective criteria that have been previously revised by media experts, materials, teacher and student responses. The LKPD revision process consists of two stages, namely the LKPD revised by the supervisor and the assessment of media and material experts and field practitioners. Dissemination Stage: the purpose of this stage is to disseminate the designed LKPD. The dissemination of this LKPD was carried out by class XI MAN 1 Deli Serdang. Furthermore, large-scale dissemination is the publication of this scientific article.

This research was conducted at MAN 1 Deli Serdang Jl. Sweet lime market XV Tanjung Morawa, North Sumatra. In February 2023 the even semester was focused on 35 class XI students of MAN 1 Deli Serdang. The research object in this study is the validity, practicality and effectiveness of STEM-based LKPD learning media on the Human Senses System material to improve creative thinking of class XI MAN 1 Deli Serdang students. The subjects in this study were class XI, totaling 35 students at MAN 1 Deli Serdang, while the informants in the study were class XI Biology teachers.

The validation assessment instrument is in the form of material expert and media expert validation sheets by providing an assessment of the product to be developed to determine the level of validity. The practicalization questionnaire is intended to determine the practicality of learning media from its users (teachers and students). Then look for the N-gain value to determine the effectiveness of students using STEM-based worksheets on sensory system material to improve students' creative thinking abilities obtained

from pretest and posttest information. In measuring the quality of LKPD using data analysis techniques by converting scores into percentages.

Data from the results of validity, practicality, and effectiveness assessments by material expert validators and media experts are in the form of the percentage of scores processed using the following formula:

$$AN = \frac{j}{p} \times 100 \tag{1}$$

Description:

AN : Percentage score

j : Total score obtained

p : Total maximum score

The validity results were obtained from the validation results by the media and material validators. Then the validation sheet is calculated using the formula:

$$\text{index } 100\% = \frac{\text{Score obtained}}{\text{Maximum score}} \times 100\% \tag{2}$$

The percentage of implementation of learning using STEM-based Student Worksheets on the Sensory System material obtained from the calculations above is then interpreted according to the criteria in the following table.

Table 1. Criteria for the Validity of Using STEM-Based Student Worksheets on Sensory Systems

Percentage (%)	Criteria	Category
80-100	Very Valid	Very Decent to use without revision
60-79	Valid	Worth using with minor revisions
40-59	Valid Enough	Decent enough to use with many revisions
20-39	Less valid	Less Worth using too many revisions
1-19	Invalid	Unsuitable for use

To obtain data from validators, field experts and students, the data collection process is carried out interactively and continuously until the data obtained is saturated and finds nothing new (Sugiyono, 2019).

Result and Discussion

The define stage is carried out by interviewing teachers and students who are at MAN 1 Deli Serdang with the aim of knowing the problems that exist in schools and knowing what media are used by teachers to students in conveying learning and understanding of students in learning through media brought by the teacher.

The design stage is planning the media to be used, such as planning the development of LKPD, setting general learning objectives, namely achieving KI and KD as well as specific goals, namely to improve creative thinking skills, choosing the LKPD format by reviewing existing LKPD, choosing Virus material. Based on STEM which will be compiled in LKPD, drafting STEM LKPD designs as teaching materials for SMA/MA.

The develop stage is the development of the LKPD used in research as teaching materials by validating the LKPD that has been made to find out whether or not the media the researcher has made is appropriate. The validation test was carried out to find out whether the media the researcher was working on was valid or not. The validation test was carried out by 4 validators including media validators, material validators, question instrument validators and questionnaire validators.

Media expert validation, this validation was carried out by Mr. Mhd Hasyim Ansyari Berutu, M.Pd. Based on the results obtained by averaging the overall validation results obtained, it shows the "Very Valid" category with a percentage of 80%. The following table shows the results of validation by the media validator

Table 2. The results of validation by the media validator

Aspect	Score obtained	Maximum score	Percentage (%)	Category
Component presentation	16	20	80	Very valid
Component of STEM	16	20	80	Very valid
Design of content of e-LKPD	28	35	80	Very valid
Final result	60	75		Very valid

Material expert validation, this validation was carried out by Mrs. Naimatussyifa Daulay, M.Pd. Based on the results obtained by averaging the validation results from material experts, it shows the "Very Valid" category with a percentage of 97%. The Table 3 shows the validation results by the material expert validator.

Table 3. The Results of Validation by the Material Expert Validator

Aspect	Score obtained	Maximum score	Percentage (%)	Category
Feasibility of presentation of the material	38	40	95	Very valid
Component of STEM	20	20	100	Very valid
Language using	10	10	100	Very valid
Final result	68	70	97	Very valid

Instrument validation questions, this validation was carried out by Ms. Naimatussyifa Daulay, M.Pd. Based on the results obtained by averaging the validation results from the instrument experts the questions show the "Very Valid" category with a percentage of 88%. The table 4 shows validation results by the questions instrument validator.

Table 4. Table of Validation Results by the Questions Instrument Validator

Aspect	Score obtained	Maximum score	Percentage (%)	Category
Contents presented	15	15	100	Very valid
Language	16	20	80	Very valid
Final result	31	35	88	Very valid

Questionnaire validation, this validation was carried out by Mrs. Naimatussyifa Daulay, M.Pd. Based on the results obtained by averaging the validation results from the questionnaire experts, it shows the "Very Valid" category with a percentage of 100%. The following table shows the results of validation by the Aspect Score questionnaire validator.

Table 5. The Results of Validation by the Aspect Score Questionnaire Validator

Aspect	Score obtained	Maximum score	Percentage (%)	Category
Contents	5	5	100	Very valid
Construction	10	10	100	Very valid
Language	10	10	100	Very valid
Final result	25	25	100	Very valid

After validating the Student Worksheets (LKPD) that will be used, then conducting practical tests on Student Worksheets (LKPD) by giving response questionnaires to teachers and students regarding the use of Student Worksheets (LKPD) as media or teaching materials which will be used.

Teacher response

The teacher who received this response questionnaire was Mrs. Try Ade Jumita, S.Pd,Gr, M.Pd from MAN 1 Deli Serdang. The results of the Student Worksheet (LKPD) responses from the Biology teacher are shown in Table 6. Based on the teacher response questionnaire in Table 6 regarding the results of the Biology teacher's responses, it can be seen that the Student Worksheet (LKPD) gets a maximum score of 15 with a percentage of 100% so that the Student Worksheet (LKPD) can be declared very practical.

Table 6. The Results of the Student Worksheet (LKPD) Responses from the Biology Teacher

Aspect	Score obtained	Maximum score	Percentage (%)	Category
Contents	2	2	100	Very practical
Language	3	3	100	
Presentation	6	6	100	Very practical
Suitability with STEM-based class discussion stages	4	4	100	Very practical
Final result	15	15	100	Very practical

Student Response

Student response questionnaires were filled out by 28 students for practical tests of the Student Worksheets (LKPD) used. This questionnaire explains the Student Worksheets (LKPD) that will be used for the research to be conducted. The results of the responses from 28 students are as shown in Table 7.

Table 7. The results of the Student Worksheet (LKPD) Responses from the Student

Student	Score obtained
1	12
2	12
3	12
4	12
5	12
6	11
7	12
8	12
9	12
10	12
11	11
12	9
13	12
14	12
15	12
16	12
17	12
18	12
19	12
20	12
21	12
22	12
23	12
24	11
25	12
26	12
27	12
28	12
Total	330
Percentage (%)	98.2
Category	Very practical

From the student response on Table 7, it can be seen that the results of student responses to the Student Worksheet (LKPD) used from 28 students got a score of 330 out of a maximum score of 336 with an overall percentage result of 98% in the very practical category. The results obtained indicate that the Student Worksheet (LKPD) used is very practical to use in learning activities.

The Dissemination stage is carried out by distributing or giving Student Worksheets (LKPD) to students and seeing the results of the effectiveness of Student Worksheets (LKPD) for students. Next, test the effectiveness of Student Worksheets (LKPD) to improve students' creative thinking skills by conducting direct trials on students who are at MAN 1 Deli Serdang. The effectiveness results are as in the Table 8.

Table 8. The Results of the Effectiveness of Student Worksheets (LKPD)

Student	Pretest	Posttest	N-Gain Score
1	75	90	0.6
2	80	100	1
3	75	90	0.6
4	75	100	1
5	80	100	1
6	75	100	1
7	75	80	0.2
8	75	90	0.6
9	80	100	1
10	80	100	1
11	85	100	1
12	80	100	1
13	100	100	0
14	80	100	1
15	80	80	0
16	75	100	1
17	80	90	0.5
18	75	100	1
19	80	100	1
20	75	100	1
21	100	100	0
22	80	80	0
23	75	100	1
24	100	100	0
25	80	100	1
26	100	100	0
27	100	100	0
28	80	100	1
Total			18.5
Average			0.6
Category			Medium

Based on the N-Gain test results on Table 8, it can be seen that the results obtained were 18.5 which were then averaged to 0.6 in the medium N-Gain category. The results of the pretest and posttest values that have been carried out in this study obtained an average pretest score of 81.9 and a posttest average score of 96.4

which indicates that it has increased by 17.7% from the pretest value to the posttest value.

Based on the results of the analysis, it can be seen that the Electronic Student Worksheet (e-LKPD) is stated to be very valid from media experts by 80%, then it is very feasible from material experts with a percentage of 97% and very valid from question instrument experts with a percentage of 88% and get very valid from the questionnaire experts with a percentage of 100%. The electronic Student Worksheet (e-LKPD) is also practical according to the results of the practicality test conducted by teachers and students with scores of 100% and 98.2% respectively in the very practical category. Electronic Student Worksheets (e-LKPD) are also effective with an N gain of 0.6 in the medium category. This is in accordance with research conducted by (Fithri et al., 2021; Dewi & Agustika, 2022; Fatimah, 2021; Prasetya et al., 2021; Yakin, 2021) where the STEM approach used in the e-LKPD allows students to improve students' creative thinking skills through filling out the e-LKPD.

STEM-based e-LKPD is an electronic student worksheet developed with a STEM learning approach using Book creator and google form. The STEM approach is an approach that combines the disciplines of science, technology, engineering and mathematics (Lou et al., 2017). Based on the presentation (Sari et al., 2013), LKPD can be used to support the learning process. Students individually and in groups can build their own knowledge with a variety of learning resources and as a tool to build student knowledge. In line with research (Simatupang et al., 2020) stated that LKPD based on Science, Technology, Engineering and Mathematics (STEM) effectively trains students' creative thinking skills seen from the improvement of students' thinking skills in each indicator. Students are taught to look for data through problem solving activities as well as through detailed and systematic steps so that students can answer various questions in a variety of ways, so that all indicators of students' creative thinking are indicators of flexible thinking, detailed thinking, original thinking, and fluent thinking. The existence of digitization in LKPD is increasingly making students enthusiastic in participating in learning so that it can improve students' creative thinking abilities.

Conclusion

Based on the results of the analysis that has been carried out, it can be concluded that the Electronic Student Worksheet (e-LKPD) is very valid with a percentage value of 80% from media experts, 97% from material experts in the very valid category and 88% from instrument experts in the very valid category and 100% with a very valid category from the questionnaire expert. Electronic Student Worksheets (e-LKPD) are also practical according to the practicality test with a

percentage value of 100% from school teachers in the Very practical category and 98.2% of student responses in the very practical category. not only valid and practical Student Worksheets (LKPD) that are used are effective with an average score of 0.6 in the moderate category and have increased from pretest scores to posttest scores of 17.7%.

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Author Contributions

Sri Yanti Tarihoran conceptualizes research ideas, designs methodologies, analyzes data, manages and coordinates responsibilities, and conducts research and process investigations. Nirwana Anas conducted a literature review and provided critical feedback on the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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