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Research Article

Developing STEM-PjBL worksheet to lift students' critical, creative, and computational thinking skill

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Abstract: This research aims to develop STEM-PjBL worksheets on eight-gr ade human excretory system material to lift students' creative, critical, and computational thinking skills. This R&D research uses the Borg & Gall model. The data collection instruments were interview sheets, validation sheets, questionnaire sheets, and also tests (pretest and posttest). The results show that the STEM-PjBL worksheet is feasible and practical as a learning instructional. The data on the effectiveness of learning media obtained an N-gain score of 88.7 (N-gain >70) and is included in the high category, this shows that STEM-PjBL worksheets can improve students' critical thinking skills. The average score for all aspects of the creative thinking assessment was 81% (creative) and the average score for computational thinking skills was 80% (very high). These results show that STEM-PjBL worksheets can improve students' creative, critical, and computational thinking abilities.

Keywords: Creative thinking, critical thinking, computational thinking, STEM-PjBL, worksheet

1. Introduction

World developments require changes in various fields including competencies so students in the 21st-Century generation are required to master these competencies (Sumantri, 2019; Warsita, 2017). The efforts of the government and teaching staff in the 21st century are to prepare reliable students for the future by creating a more innovative learning system and improving the 4C skills, i.e. critical thinking, communication, creative thinking, and collaboration skills. Computational thinking skills are included in the 5 Cs, previously only 4C because they are needed to improve students' skills in solving complex problems (Azmi & Ummah, 2021; Nuvitalia et al., 2022; Sa'diyyah, 2021). The development of 21st-Century education requires creative, critical, and computational thinking skills. The condition of thinking skills in Indonesia is currently at a low level, this is because thinking skills require high reasoning power not only during exams but must be carried out in the learning process (Fithri et al., 2021; Hasanah et al., 2021). It will be difficult for students to develop critical thinking skills if the learning process does not apply learning instructional and models that train critical thinking skills (Basthomi et al, 2021). The low level of creative thinking skills is due to the learning process not encouraging students to use their imagination so they can apply learning to daily activities (Ermaita, 2016; Sutama et al., 2014). The low level of computational thinking skills is caused by learning approaches and models that limit students from developing themselves to solve problems structurally (Angraini et al., 2022; Supiarmo et al., 2022).

The learning process of junior high school students requires learning instructional that can not only transform knowledge but also encourage high-level thinking skills such as analysis, synthesis, critical, creative, and innovation through scientific work experience (Mardhiyana & Sejati, 2016; Untari et al., 2018). Students often experience difficulties in understanding learning concepts because students are not free to construct their knowledge so they cannot involve themselves in the learning process (Jumaisyaroh &

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Hasratuddin, 2016). Therefore, efforts need to be made by teachers to create contextual learning instructional so that they can improve students' thinking skills.

Teaching tools that can increase learning effectiveness are interactive student worksheets (Wati et al., 2021). The worksheet is made interactively so that the lesson material can increase innovation and increase student creativity (Komang et al., 2023; Miqro et al., 2021). The development of worksheets must direct contextual learning so that students can understand the lesson material well (Rawa, 2020). Contextual learning using worksheets influences the improvement of students' thinking skills (Nareswari et al., 2021). In worksheet development, a learning approach is needed that is appropriate to contextual learning, namely the science, technology, engineering, and mathematics (STEM) approach.

Learning with a STEM-based approach can produce a meaningful learning process for students, through the mathematical integration of knowledge, concepts, and skills (Dewati et al., 2019; Ismayani, 2016; Nurhikmayati, 2019). The STEM approach modifies learning by integrating various subjects including science consisting of (biology, physics, chemistry), technology, engineering, and mathematics (Sartika, 2019; Vistara et al., 2022). To achieve learning success, an appropriate learning model is needed because it will influence learning outcomes. According to several researchers, one of the learning models that can be integrated with the STEM approach is the project-based learning model, namely project-based learning (PjBL), this is because the PjBL learning model has characteristics that are under contextual learning (Afriana et al., 2016; Astuti et al., 2019; Sari, 2018).

STEM-PjBL integrates interdisciplinary knowledge of science, technology, engineering, and mathematics through project-based learning strategies. Students can actively explore real experiences and find solutions to life problems (Aini et al., 2022; Sukmawijaya et al., 2019). The PjBL model has a syntax that can support learning contextually through complex activities such as giving students the freedom to explore and plan learning activities (Priantari et al., 2020). STEM-PjBL learning model can support 21st-century creative, critical, and computational thinking skills, where the learning system requires students to learn actively and be directly involved in learning activities (Fitriyani et al., 2020; Rohma et al., 2023).

Based on the results of initial observations through interviews with science teachers at Muhammadiyah Junior High School (JHS) 1 of Malang, the factor that causes students' low creative, critical, and computational thinking skills is that the learning model used still limits students from exploring learning activities and the problem activities given are not yet contextual. This is supported by the results of observations that the teaching tools in the form of lesson plans made by teachers do not meet the syntax according to the learning model used and the worksheet used answers more questions so that there is a lack of activity which causes students' creative, critical and computational thinking to not develop optimal (Nurazizah & Nurjaman, 2018).

Several studies have tried to develop students' worksheet based on project, but the variables and learning materials in this research are different. By explaining the problems above, this research aims to develop STEM-PjBL integrated worksheet to students' creative, critical, and computational thinking skills.

2. Methods

2.1 Research Design

R&D research was carried out from January to May 2023 at Muhammadiyah Junior High School 1 of Malang. The subject of this research was students of eight-grade. The development research steps used in this research are as shown in Figure 1.

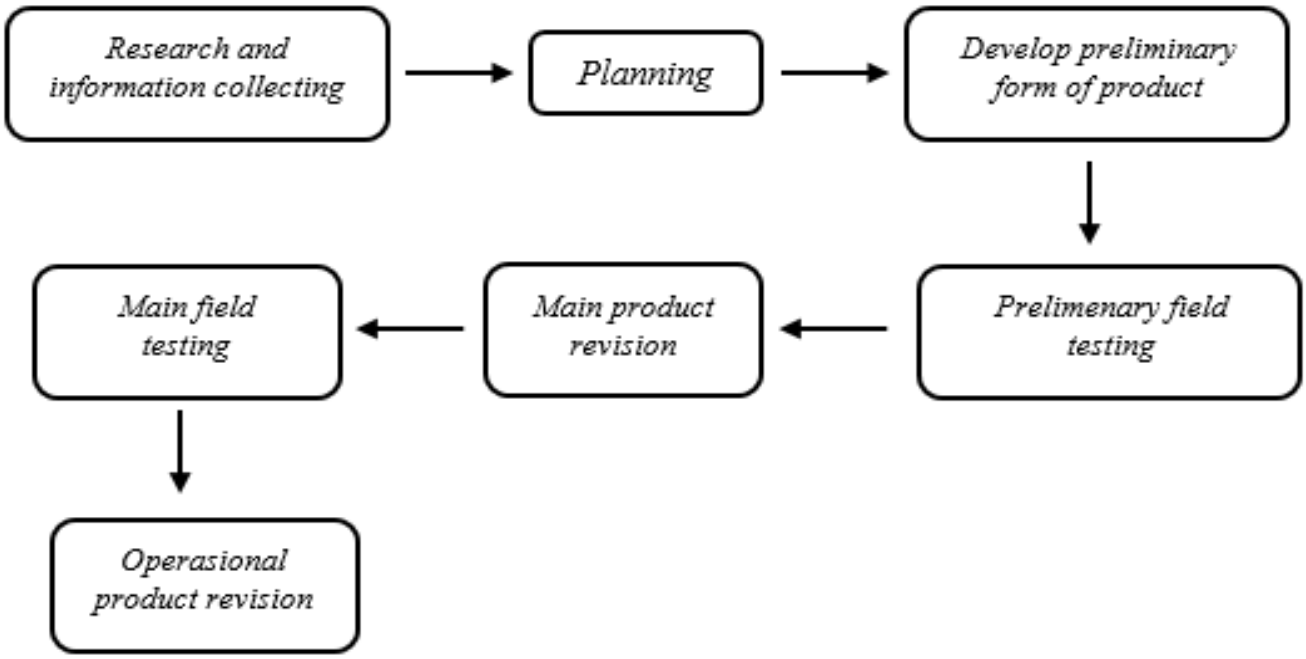

Figure 1. The development steps through Borg & Gall model

2.1.1 Research and information collecting

The initial stage carried out by researchers before developing learning tools was conducting a preliminary study. The activities carried out are collecting information and data through interviews with science teachers about the learning process carried out, especially the use of learning tools and materials that need to be developed.

2.1.2 Planning

In this planning stage, researchers designed teaching tools that were developed according to the needs of teachers and students by choosing one even semester material, namely the excretory system in the kidneys with the K-13 following basic competency (analyzing the humans' excretory system and understanding the excretory system disorders as well as health efforts maintain) and application the knowledge to in maintaining personal health. The learning tools developed use the STEM approach and the PjBL learning model.

2.1.3 Develop preliminary form of product

The initial stage of design development involves compiling material based on basic competencies, indicators, and learning objectives. This stage is carried out by developing material related to the renal excretory system and its disorders by discussing one of the diseases that interfere with the functioning of the kidneys. The students' worksheet also uses the STEM approach and PjBL learning model so that it emphasizes the relationship between science, technology, engineering, and mathematics knowledge and skills. This development stage produces a worksheet that has been validated by material experts and media experts to obtain product feasibility so that it is ready to be tested on students.

2.1.4 Preliminary field testing

The initial testing phase was carried out using a worksheet that had previously been validated. The trial involved six students who were selected using purposive sampling and represented the characteristics of all eighth-grade students. This trial was carried out using worksheets and guidelines containing instructions, while the learning material involved science teachers. This trial activity was closed by giving student and teacher response questionnaires to determine the practicality of the media that had been created.

2.1.5 Main product revision

At this stage we revise the notes and suggestions obtained during the scale trial implementation. Revisions to the trial results were obtained from suggestions and

recommendations from media experts, material experts, teacher assessments, and student responses.

2.1.6 Main field testing

The field trial stage is carried out after the worksheet has gone through two developments, validation by experts, and has been tested initially. This field trial involved 30 eighth-grade students of Muhammadiyah JHS 1 of Malang.

2.1.7 Operational product revision

This stage is the second improvement after field trials. This product revision is to strengthen the product that has been developed and refinement of this product is based on the results of the assessment that has been carried out.

2.2 Research Subject

Research subjects are needed to determine the feasibility, practicality, and response to the product being developed. The subject of this research was carried out by two material experts, two media experts, as well as students and teachers. The material experts and media experts used are lecturers with a master's degree in Biology Education and have a minimum of five years of teaching experience. The science teachers used in this research are teachers with a bachelor's degree in the Faculty of Teacher Training and Education with a minimum of five years of teaching experience. The students involved were eighth-grade students of Muhammadiyah JHS 1 of Malang who had taken material on the human excretory system.

2.3 Data Collection Technique

The data generated from this research is in the form of (1) quantitative including expert assessment scores, teacher responses, student responses, and test results, and (2) qualitative form the teacher interview results, responses and expert suggestions. regarding the worksheet being developed. The instruments used in this research include (1) interview sheets, to collect data about the material to be published, the needs of teachers and students, and the importance of developing STEM-PjBL-based worksheets; (2) validation sheet, in the form of a questionnaire used to assess the suitability of the learning media created; and (3) an assessment sheet for teacher and student responses, in the form of a questionnaire used to assess the practicality of the learning media created.

2.4 Data Collection Technique

Instrument data processing techniques are assessed based on the scores listed on the questionnaire using a Likert scale. The Likert scale is used to measure behavior or attitudes, opinions and assumptions of a person or group of people about a phenomenon (Suwandi et al., 2018). The Likert scale scores used in stages are very good (4), good (3), fair (2), and poor (1). The data obtained is then converted into a percentage. Validity and practicality scores are calculated using the Formula [1]:

$$\text{Score} = \frac{Total\ score\ was\ obtained}{Total\ score} \text{ x } 100\% \quad [1]$$

2.4.1 Experts validation

The assessment of the quality of the instrument by the expert team was assessed based on two aspects, namely the suitability of the material and the suitability of the STEM-PjBL worksheet being developed. After the instrument is assessed using a Likert scale and converted into a percentage, the percentage value obtained is converted into a qualitative value according to the validity category criteria which can be seen in Table 1.

Table 1. Level of validity criteria

Percentage (%)	Qualification	Remarks
81-100	Very high	Very feasible, no revisions are needed
61-80	High	Feasible, no revisions are needed
41-60	Moderate	Quite feasible, need little bit revisions
21-40	Low	Not feasible, need more revisions
0-20	Very low	Very unoworthy, need much more revisions

2.4.2 Practicality tests

Students' worksheet practicality scores were obtained using instruments filled in by teachers and students. The assessment was carried out using a Likert scale and converted into a percentage. The percentage obtained is converted into a qualitative in determining the user response category, whether teachers or students. The criteria for the practicality category of teacher and student responses can be seen in Table 2.

Table 2. Level of practicallity criteria

Interval	Categories
86-100	Very practical
71-85	Practical
56-70	Quite practical
41-55	Impractical
0-40	Very impractical

2.4.3 Critical thinking

Test critical thinking skills using five essay questions that cover five indicators of critical thinking skills. Analysis of increasing critical thinking skills was analyzed using N-Gain and T-test with significance <0.05. N-Gain is used to calculate the magnitude of the increase in learning outcomes using Formula [2], while the T-test is used to calculate whether the increase in critical thinking skills is significant or not (Mutmainnah et al., 2021). The normality test was carried out at the beginning to ensure that the data was normally distributed. The N-gain score criteria are divided into three categories (Table 3).

$$\text{N-Gain} = \frac{Postest - Pretest}{Total\ score - Pretest} \times 100\% \quad [2]$$

Table 3. N-Gain score criteria

Percentage (%)	Categories
N-gain > 70	High
30 ≤ N-gain ≤ 70	Moderate
N-gain < 30	Low

2.4.4 Creative and computational thinking

Assessment of critical thinking and computing skills through observations and products created by students. This analysis is carried out by comparing the score obtained with the maximum score. The criteria for assessing creative and computational thinking skills can be seen in Table 4 and Table 5. The non-test score assessment Formula according to Ridha et al (2022) is as follows [3].

$$\text{Score} = \frac{\text{Score was obtained}}{Maximum\ score} \times 100\% \quad [3]$$

Table 4. Critical thinking score criteria

Score	Remarks
81 - 100	Very creative
61 - 80	Creative
41 - 60	Moderate
21 - 40	Less creative
0-20	Increative

Table 5. Computational thinking score criteria

Score	Remarks
86 - 100	Very good
76 - 85	Good
60 - 75	Quite good
55 - 59	Low
<55	Very low

2.4.5 Validity and reliability tests

The validity test was carried out using product moment correlation with the help of SPSS software on the evaluation questions. After being tested for validity, three of the five items analyzed were declared valid (p-value <0.005). Reliability test analysis was carried out using Cronbach's alpha test with the help of SPSS software on the evaluation questions. This research uses 5 essay questions. After being analyzed using Cronbach's alpha reliability test (Loka , 2019), the resulting value was 0.650. Thus, this instrument is declared reliable. The reliability test criteria are shown in Table 6.

Table 6. Reliability criteria

Reliability Index	Criteria
0.80-1.00	Veri high
0.60-0.79	High
0.40-0.59	Moderate
0.20-0.39	Low
0.00-0.19	Very low

3. Results

The results of observations and interviews with science teachers with obstacles show that students' ability to think creatively both during discussions and question and answer sessions is still low because of the low level of student participation, especially in providing ideas during discussions. Moreover, the students' worksheets used do not provide contextual problems because they do not originate from the surrounding environment, so students have difficulty in elaborating on these problems. Apart from that, the character of students tends to memorize so that the learning outcomes obtained are only short-term memory. Students sometimes still have difficulty linking organ structure and function, as well as solving problems related to disorders of the excretory system, especially the kidneys. Therefore, this research product focuses on contextual problems presented in the form of students' STEM-PjBL worksheets on the human excretory system material.

The initial stage of design development involves compiling material based on core and basic competencies. The material included in the students' worksheet is the renal excretory system and its disorders. The students' worksheet was made with an attractive appearance and organizes the activities in it based on the STEM approach so that it contains STEM characteristics. The worksheet cover shows that this document was developed based on STEM which involves various approaches in solving problems in the excretory system, including a review of aspects of science, technology, engineering and mathematics.

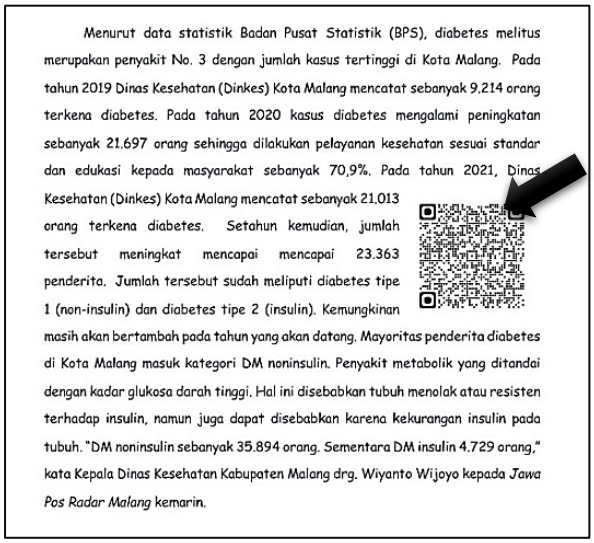
Menurut data statistik Badan Pusat Statistik (BPS), diabetes melitus merupakan penyakit No. 3 dengan jumlah kasus tertinggi di Kota Malang. Pada tahun 2019 Dinas Kesehatan (Dinkes) Kota Malang mencatat sebanyak 9.214 orang terkena diabetes. Pada tahun 2020 kasus diabetes mengalami peningkatan sebanyak 21.697 orang sehingga dilakukan pelayanan kesehatan sesuai standar dan edukasi kepada masyarakat sebanyak 70,9%. Pada tahun 2021, Dinas Kesehatan (Dinkes) Kota Malang mencatat sebanyak 21.013 orang terkena diabetes. Setahun kemudian, jumlah tersebut meningkat mencapai mencapai 23.363 penderita. Jumlah tersebut sudah meliputi diabetes tipe 1 (non-insulin) dan diabetes tipe 2 (insulin). Kemungkinan masih akan bertambah pada tahun yang akan datang. Mayoritas penderita diabetes di Kota Malang masuk kategori DM noninsulin. Penyakit metabolik yang ditandai dengan kadar glukosa darah tinggi. Hal ini disebabkan tubuh menolak atau resisten terhadap insulin, namun juga dapat disebabkan karena kekurangan insulin pada tubuh. "DM noninsulin sebanyak 35.894 orang. Sementara DM insulin 4.729 orang," kata Kepala Dinas Kesehatan Kabupaten Malang drg. Wiyanto Wijoyo kepada *Jawa Pos Radar Malang* kemarin.

Figure 2. Orientation in activity 1 based on contextual problem among Malang citizen

Student worksheets are organized into several activities that represent the steps of scientific thinking, starting from orienting a problem and exploring it to finding a solution. Activity 1 contains cases that are relevant to everyday life. In this case, we take problems related to diabetes. According to several references, diabetes is one of the diseases with the highest prevalence in Malang City. Therefore, we raise diabetes as a contextual problem. We also provide a link in QR form (Figure 2) which contains data and knowledge sources to help students understand the problem more deeply.

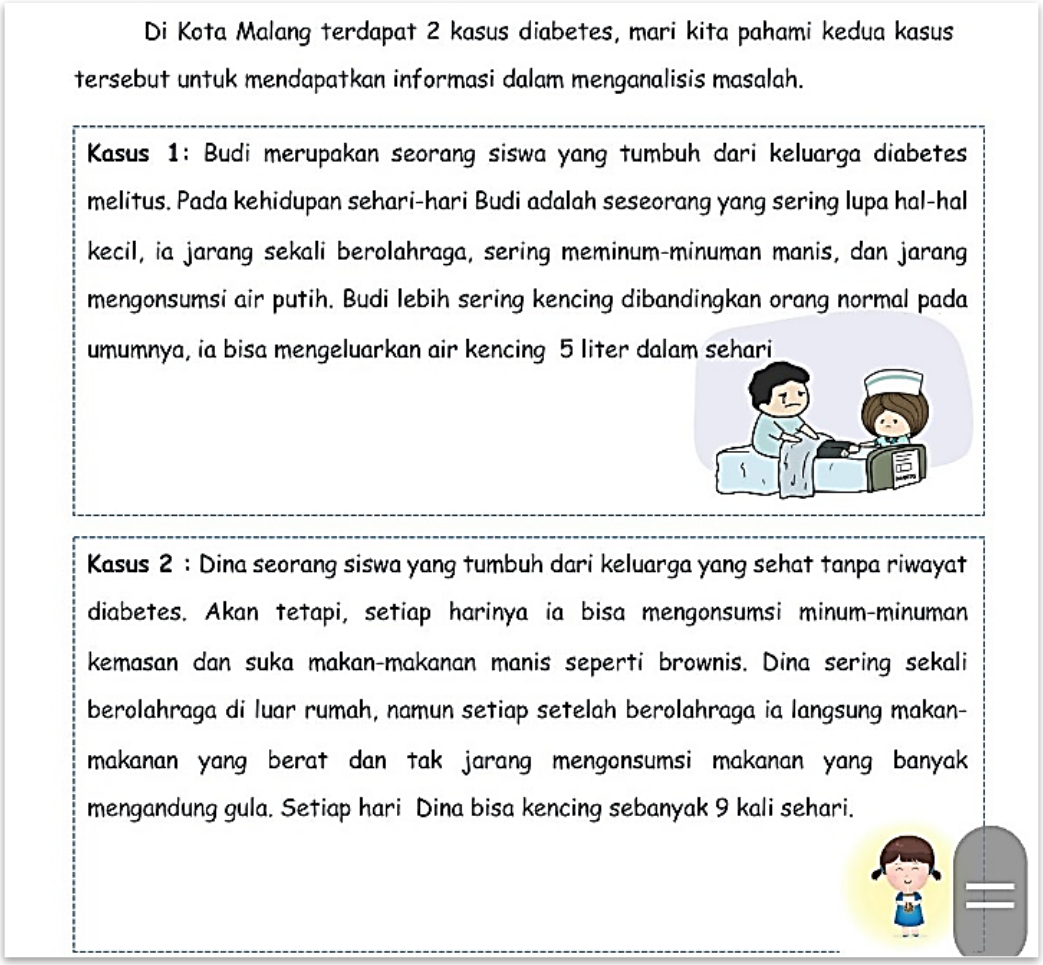

Figure 3. Two kinds of diabetes case simulations in the worksheet

Furthermore, we developed a case simulation based on diabetes as the main problem. Both cases refer to the characteristics of diabetes such as its type and how likely each person is to suffer from diabetes. Students will discuss these two cases later to create a solution using a STEM approach (Figure 3). This activity provides space for students to grow and familiarize themselves with creative and computational thinking skills through a series of learning steps in the worksheet. In its implementation, they are asked to design a project to create a diet pattern for each case. Furthermore, the eating patterns created by students need to consider various aspects from the point of view of science, technology, engineering, and mathematics in one learning activity project unit (Figure 4).

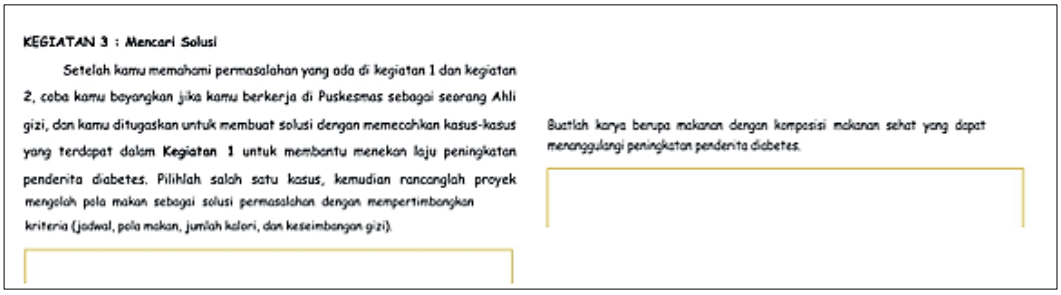

Figure 4. Project activities to solve the problem

The STEM framework in solving problems describes how students can connect one scientific discipline with other scientific disciplines. This is important for students to map because no problem can truly be solved from just one scientific point of view. This is in line with research by Teo et al (2021) which states that the complexity of a problem is something that needs to be considered in solving the problem. The STEM framework for diabetes cases is presented in Figure 5.

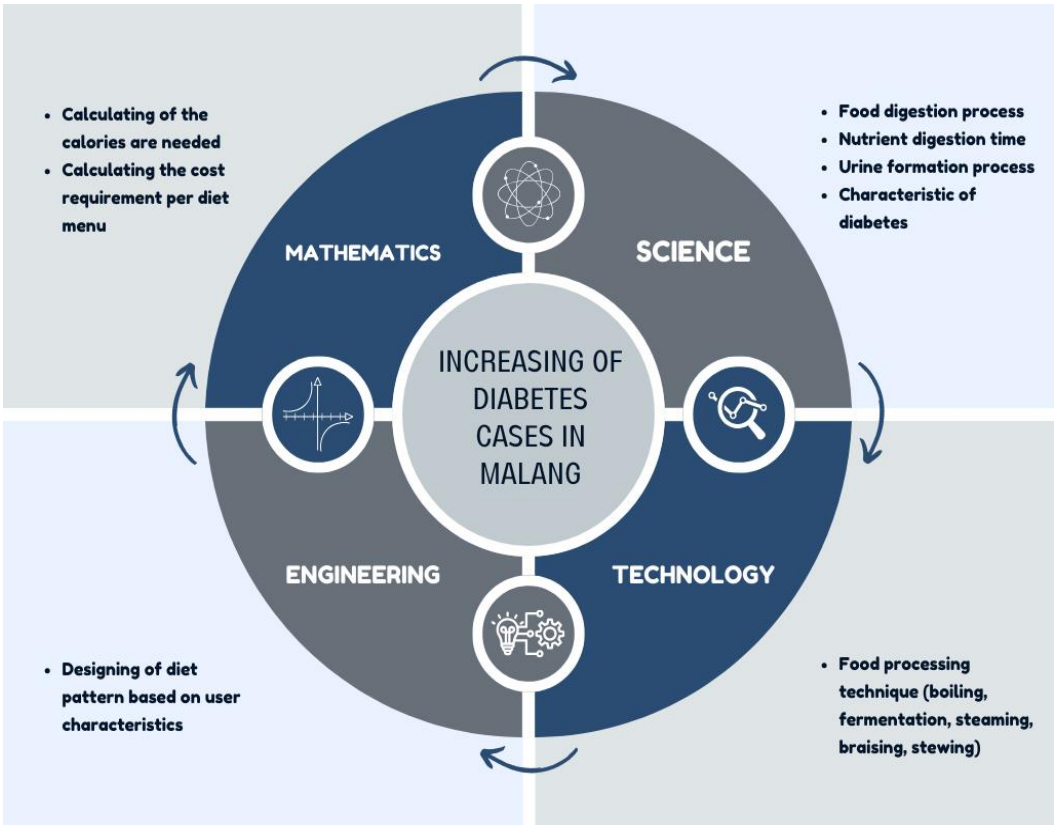

Figure 5. STEM framework in solving diabetes cases

This STEM learning concept is also in the teacher's manual, which is a single worksheet to help complete the learning media. This framework functions to apply STEM learning according to appropriate learning concepts and principles for teachers. At the development stage, before trials are carried out, the resulting product needs to be validated by experts. The following are the assessment results from the media expert validators in Table 7 and material experts in Table 8 regarding the worksheet that has been developed.

Table 7. The results of media experts validation

Aspects	Media Expert 1		Media Expert 2	
	Percentage (%)	Qualification	Percentage (%)	Qualification
Presentation	94	Very feasible	81	Very feasible
Component	97	Very feasible	97	Very feasible
Suitability with STEM and PjBL	92	Very feasible	82	Very feasible
Average Score	**94**	**Very feasible**	**87**	**Very feasible**

Table 8. The results of material experts validation

Aspects	Material Expert 1		Material Expert 2	
	Percentage (%)	Qualification	Percentage (%)	Qualification
Content eligibility	100	Very feasible	80	Feasible
STEM learning	89	Very feasible	80	Feasible
Average Score	**95**	**Very feasible**	**80**	**Feasible**

The results of the assessment from the experts stated that the STEM-PjBL worksheet received a feasibility percentage from media expert 1 with a total average of 94%, media expert 2 with a total average of 87%, material expert 1 with a total average of 95%, and material expert 2 with a total average of 80%. The four experts' assessments showed that the worksheet was suitable for use with revision notes. In addition, an initial field trial stage was carried out using products that had been revised as a result of suggestions and recommendations from experts. The results of the worksheet assessment in the initial trial stage carried out by students and teachers contained a respondent questionnaire to test the practicality of the learning media. Instruments for teachers include material assessment and media assessment. The following practical test results can be seen in Table 9.

Table 9. Practicality test result

Respondents	Percentage (%)	Category
Students	79	Practical
Teacher (media)	92	Very practical
Science Teacher	94	Very practical

The field test phase involved 30 students from Muhammadiyah JHS 1 of Malang. Before students use learning media, researchers provide a pre-test sheet to measure students' critical thinking abilities. The researcher then gave the worksheet to students who had formed heterogeneous groups consisting of five people in one group, after which students were invited to understand the contents of the worksheet before working on it.

Figure 6. Field trial test activity using STEM-PjBL worksheet

Students in groups discuss a project that can solve problem cases on the worksheet by linking daily lifestyle patterns so that learning is carried out contextually (Figure 6). The results obtained from working on LKS are the result of assessing student responses to determine the practicality and effectiveness of worksheet learning media on critical thinking skills which are processed from pre-test and post-test results, while creative and computational thinking skills are obtained from working on worksheets and making products that produced by students. Based on the accumulated pre-test and post-test data, there was an increase in the average from 49 to 90. This value is the student's value when learning using the media developed. This proves that there is an increase in student learning outcomes regarding the human excretory system. The data graph comparing the pretest and posttest results is presented in Figure 7.

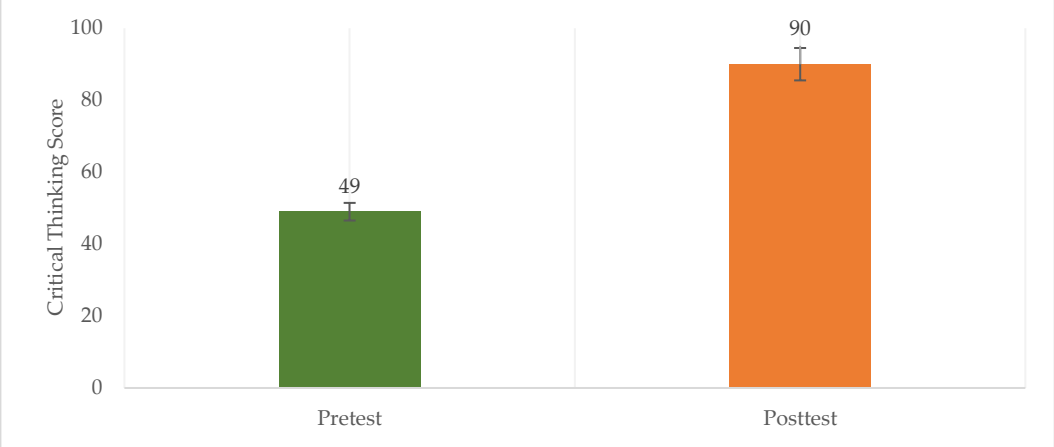

Figure 7. The critical thinking skills scores before and after learning with STEM-PjBL

The results of the Kolmogorov-Smirnov test report that the critical thinking skills data is normally distributed D(30) = 0.150, p = 0.084. After the normality test was carried out, it was continued with the paired T-test. These results also show significant differences in students' critical thinking skills between before (M = 48.83, SD = 13.04) and after learning (M = 90.16, SD = 9.33), t(29) = 17.07, p < 0.001. These results show that the STEM-PjBL worksheet can improve students' critical thinking skills on the human excretory system material. The results of the T-test can be seen in Table 10.

Table 10. T-test results

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	48,8333	30	13,04391	2,38148
	postes	90,1667	30	9,32954	1,70333

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	
Pair 1	Pretest postes	-41,33333	13,25697	2,42038	-46,28357	-36,38310	-17,077	29	,000

Meanwhile, the N-gain score was 88.7 (N-gain > 70) so it is classified in the high category, this shows that STEM-PjBL worksheets can improve students' critical thinking skills in the human excretory system material. The N-gain results can be seen in Table 11.

Table 11. N-Gain analysis

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
N-gain_skor	30	74,18	99,33	88,7369	9,02917
Valid N (listwise)	30				

Testing the effectiveness of learning media on creative thinking skills is carried out using a non-test assessment rubric according to the components of creative thinking skills. The results of calculating the average score from all aspects of the creative thinking assessment obtained 81% (creative) and can improve students' creative thinking skills. Following are the results of the creative thinking assessment based on aspects that can be seen in Figure 8.

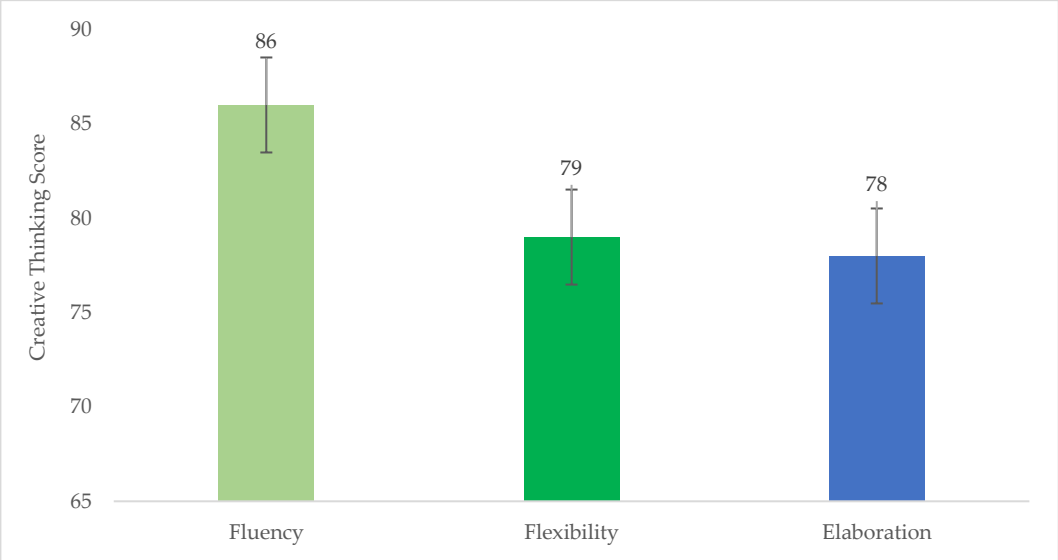

Figure 8. Creative thinking skills score

The results of calculating the average score from all aspects of the computational thinking assessment obtained a percentage of 80% in the very high category and can improve students' computational thinking skills. Following are the results of the creative thinking assessment based on aspects which can be seen in Figure 9.

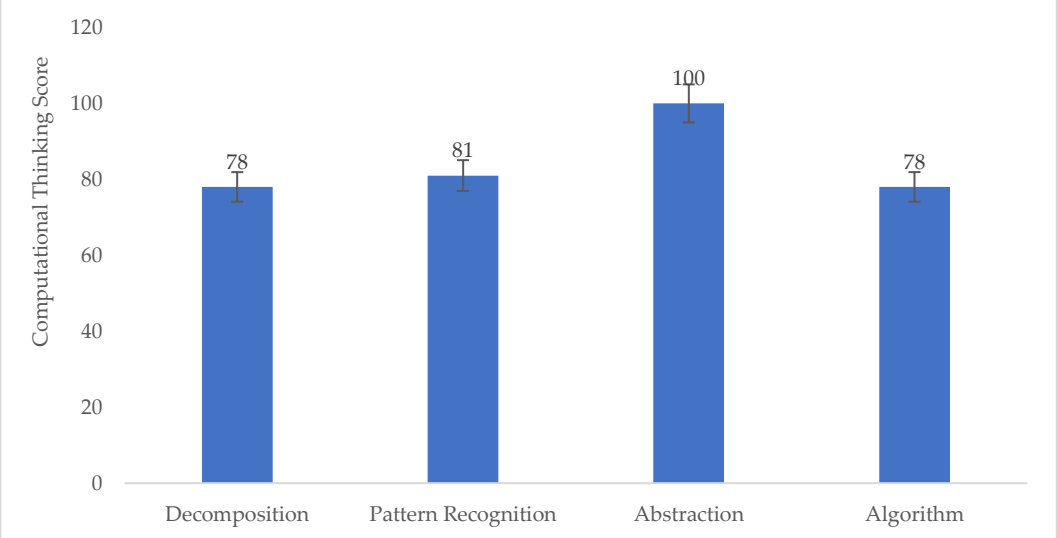

Figure 9. Computational thinking skills score

4. Discussion

The results of media validation include three aspects, namely worksheet presentation, media components, and suitability of STEM-PjBL. It was found that the total feasibility test average from the two media experts was 94% and 87% respectively with very feasible qualifications. The feasibility percentage of the three aspects shows that they are very feasible according to the media validation test carried out by Susilawati & Agustinasari (2022), that aspects that have very feasible criteria can be used as learning media. Moreover, the results of material validation including content feasibility aspects and STEM-based learning aspects show that the total average material feasibility test by experts is 95% (very feasible) and 80% (feasible), respectively. These results indicate that this worksheet is suitable for use in learning. This is reinforced by research (Andani et al., 2021; Simatupang et al., 2020; Wardah, 2016) which states that product development needs to pay attention to the validation results of experts and needs to continue to carry out revisions by considering suggestions from experts.

The practicality test by the teacher includes four aspects, namely layout, design, content typography, and illustration of the content in the worksheet. The average obtained through media practicality testing by teachers was 92% (very practical). Furthermore, the material practicality test including self-instruction, self-contained, adaptive, and user friendly obtained an average of 94% with very practical qualifications. This is in accordance with the practical qualifications from previous research that 80% to 100% have very practical qualifications (Rahayu et al., 2019). The practicality questionnaire filled out by the teacher aims to obtain information regarding the practicality of the learning device based on the teacher's predictions and considerations after using the device during the learning process (Revita, 2019). The results of student responses to determine the practicality of the STEM-PjBL worksheet were carried out during initial field trials. Aspects of practical testing by students include aspects of interest, material aspects, and language aspects. The average obtained through practicality testing was 79% with practical qualifications (Masnah et al., 2018; Revita, 2019). Based on this, the three aspects in testing the practicality of the worksheet that have been developed have met the ease of use of the worksheet but still need revision in accordance with suggestions and recommendations from respondents (Akmal & Aini, 2022).

Based on the T-test results, it shows that there is a significant difference between the pretest and posttest. Furthermore, the N-Gain test showed a score 88.7 (N-gain > 70) and is classified as high, so it can be said that the STEM-PjBL worksheet is effective in improving students' critical thinking skills (Kurniawan et al., 2019). This is in accordance with the statement by Usboko et al., (2021) and Linh et al (2019) that learning using the STEM-PjBL approach has an effect on students' critical thinking abilities. Students can experience increased critical thinking after treatment in the form of learning using worksheets because the STEM framework can build students' understanding of how things work and facilitate students in making solutions, thus leading students to develop more critical thinking skills (Fitriyah & Ramadani, 2021; Ritonga & Zulkarnain, 2021).

The results of the creative thinking analysis which include fluency, flexibility and elaboration obtained an average score of 81 with details of 86, 79 and 78 respectively. These results indicate that the level of students' thinking skills is classified as creative. This is in accordance with Choirunnisakh and Fitrihidajati (2020) who state that creative thinking skills are seen from the process of students producing many possible ideas and ways that are broad and varied. Students' activities in making products to solve problems in a case can produce solutions from creative thinking. Creative thinking requires a child to be able to communicate thoughts or ideas about a problem topic, solve problems, have various solutions, and master problem concepts in order to be able to engage in creative thinking (Arnyana, 2019; Haifatudzikroh, 2019).

The results of students' computational thinking skills are in line with the results of creative thinking skills. The results of the analysis show that the average of the four aspects of computational thinking is 80. Students are able to solve problems with computational thinking components, this can be seen from students' computational thinking abilities to describe problems and determine problem solving solutions (Alkautsar et al., 2023; Walker & Kafai, 2021). The development of STEM-PjBL worksheets is carried out using contextual learning processes such as problem solving in solving daily problems so that computational thinking skills are formed (Ahsana et al., 2019). Worksheets that are able to improve computational thinking skills can familiarize students with discovering their own concepts, get used to formulating steps to solve problems, and can solve problems using the same problem solving (Sugiyarta, 2023).

5. Conclusion

This research has developed a STEM-PjBL worksheet with the topic of the human excretory system. The results of the assessment analysis from the team of material experts and media experts in testing the suitability of the learning tools, found the category very feasible. The results of user response tests (teachers and students) to analyze practicality, obtained a practical category for use in the learning process. The results of using worksheets developed using the STEM approach and the PjBL model can improve students' creative, critical and computational thinking skills.

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