Development of PjBL-based Canva Teaching Media with STEM approach to Improve Students' Critical Thinking

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Abstract - *Science is a subject that contains activities to understand the universe through observation and using specific procedures to get a conclusion so that it will be more meaningful and can help improve the quality of human resources if implementing learning that allows students to develop knowledge and the ability to apply their knowledge in dealing with problems in everyday life. This study aims to analyze the characteristics of Canva teaching media based on Project-based Learning (PjbL) with the Science Technology Engineering and Mathematics (STEM) approach to increasing students' critical thinking. Based on predetermined characteristics, analyze the validity of Canva teaching media based on Project-based Learning (PjbL) with the Science Technology Engineering and Mathematics (STEM) approach to increasing students' critical thinking, and analyze the effectiveness of Canva teaching media based on Project-based Learning (PjbL) with the Science Technology Engineering and Mathematics (STEM) approach to increasing students' critical thinking. This study is development research with the ADDIE development model. The ADDIE model has five stages, namely Analysis, Define, Design, Implement, and Evaluate. The data analysis used in this research is the RASCH model, Anacova test, and t-test. The results of the study can be concluded that the characteristics of Canva teaching media contain the syntax of the PjbL learning model, namely determining fundamental questions, planning product design, preparing a product manufacturing schedule, monitoring project progress, assessing results, and evaluating with detailed explanations integrated in conventional biotechnology science subjects. The feasibility of teaching materials is declared valid in terms of material, media, language, and learning with a validity of 0.89 and feasible to use in science learning to improve students' critical thinking skills. The results of the effectiveness test can be declared effective in improving students' critical thinking skills.*

Keywords: *Science; Learning Media; Canva; PjbL; STEM*

INTRODUCTION

Education is believed to improve and prosper human life (Setiawan et al., 2022). Fitriyah & Ramadani (2021) state that the development of 21st-century skills has been pursued in the world of education through changes in the national curriculum to create a superior and reliable generation in facing the era of globalization. One of the goals of 21st Century education is to develop students' thinking skills, one of which is critical thinking skills (Susilawati et al., 2020). Science learning is learning that can stimulate students' thinking skills including four main elements, namely curiosity, processes such as problem-solving procedures through the scientific method, products in the form of facts, principles, theories, and laws, and applications which include the application of scientific methods and science concepts in everyday life (Indrawati & Nurpatri, 2022). Science is a subject that involves activities to understand the universe through observation and using specific procedures to conclude (Wahyuni, 2021). Science learning will be more meaningful and helpful in improving the quality of human resources if it applies learning that allows students to develop knowledge and apply their knowledge in dealing with problems in everyday life. (Rohmah et al., 2019).

Critical thinking skills are essential for life, work, and functioning effectively in all

other aspects of life (Jamaluddin et al., 2020). Ariadila et al. (2023) stated that in the world of education, critical thinking skills are essential skills that must be mastered by students so that they can master concepts, solve problems presented in learning, and be able to apply these concepts to real-life situations. Learning is no longer considered memorizing facts but rather using knowledge in productive and efficient learning that requires individuals who question, analyze, and think critically (Basak & Yucel, 2024).

The solution to improve and achieve learning objectives is that teachers must apply learning models that can motivate students and direct students to improve their critical thinking skills to solve problems in learning provided by the teacher. Then, students' critical thinking skills can be improved by implementing student-centered learning (Isvida et al., 2024). One of the learning patterns that can be used is the application of STEM learning (Science, Technology, Engineering, and Mathematics) based on PjBL (Project Based Learning) (Fitriyah & Ramadani, 2021). Project-based learning involves students investigating problems and producing a real product, which can make learners actively involved and are expected to have independence in designing a learning activity and producing a real product or project (Darmastuti et al., 2025).

The STEM approach shapes the resources of people who can think critically, creatively, innovatively, communicate, and collaborate (Susanti & Kurniawan, 2020). The interdisciplinary nature of STEM, built on integrating science, math, engineering, and technology, helps students apply their knowledge from various disciplines to create new products (Yulaikah et al., 2022). This is to the research results by Gandi et al. (2021), which state that the result showed that implementing project-based learning lessons integrated STEM affected students' critical thinking skills.

The existence of learning media as a means of conveying messages in the learning process is a significant thing to pay attention to because it has a role in explaining abstract things and showing hidden things. The ambiguity and complexity of teaching materials can be helped by presenting learning media as intermediaries for conveying information in the learning process (Nurdin et al., 2023). With the learning media, students can create more enjoyable learning conditions for students not only to understand the concept of the material but through student worksheets, students can gain concrete experience regarding the tasks and problems to be discussed (Syahfitri & Sulaiman, 2023).

One of the platforms in the development of teaching media is Canva. The Canva application can positively increase student learning motivation because of its uniqueness, visual appeal, better understanding, creativity and exploration, and accessibility and flexibility (Asnawati & Suti'ah, 2023). Canva has several advantages as a learning media, including having a variety of design templates that are many and interesting, able to increase teacher creativity in designing learning media, students can restudy whenever and wherever learning media because it is available online, can collaborate with other teachers in designing media and sharing learning media (Sari et al., 2022). This is because in canva, there are many templates that can be used to create infographics, graphics, posters, presentations, brochures, logos, Instagram posts, cards, invitation magazine covers, photo collages, business cards, desktop wallpapers, reports, certificates, novel covers, social media animations,

announcements, menus, videos, graphic organizers, your story, messages, labels, class agendas, calendars, ID cards, mobile first presentations, planners, programs, ebook covers, and storyboards (Irmansyah & Qaaf, 2023).

Some existing research on the use of Canva, has not shown the development of Canva as a PjBL-based learning media with a STEM approach. Irmansyah & Qaaf (2023) using Canva to develop SAVI-based learning media. Sari et al. (2022) also used Canva to develop learning media, but the learning media developed was not PjBL-based and not to develop critical thinking skills. Syah's research aims to improve critical thinking skills, but does not use Canva as a learning medium and does not use the PjBL model in its learning activities. Based on the initial observations of teachers and students, information was obtained that science learning has not used teaching media that can be used flexibly. Science learning is also felt to have not entirely allowed students to learn to apply the concepts obtained in everyday life. Therefore, to utilize technology in learning activities following the times, researchers want to develop a teaching media using PjBL-based Canva with a STEM approach to improving students' critical thinking skills.

RESEARCH METHODS

This research is a development research or Research and Development (R&D) with the ADDIE development model. ADDIE is often used because its stages describe a systematic approach to instructional development (Mulyasari et al., 2023). ADDIE consists of analysis, design, development, implementation, and evaluation (Cahyadi, 2019). The procedure/stages of product development are illustrated in the diagram below:

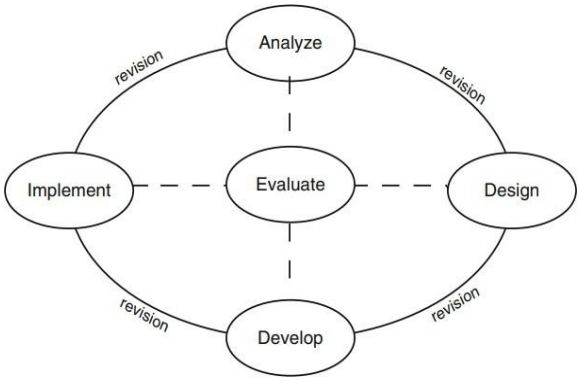

Figure 1. Product Development Stage ADDIE (Mulyasari et al., 2023)

The first stage is the analysis stage. At this stage, a preliminary study is conducted to analyze the needs and problems in school learning activities and identify appropriate solutions to overcome these problems. Generally, the steps in the analysis stage are validating the performance gap, determining instructional objectives, analyzing learners, identifying available resources, and developing a management project plan. The second stage is the design stage, which involves making Canva media designs based on project-based learning and STEM approaches to conventional biotechnology materials. The design in question is as follows: a) cover, on the cover page, there is the title of the material, pictures of conventional biotechnology products, and the author's identity; b). Learning objectives; c) basic principles of conventional biotechnology; d) definition of conventional biotechnology; e) definition of fermentation; f) steps in making tempeh; g) problems that arise in making tempeh.

The third stage is the development stage, which aims to realize the design prepared in the previous stage into a product ready to be implemented. The development stage includes activities to compile content, select and develop teaching materials, and carry out formative revisions and trials. This activity includes developing products made in the previous stage (Design), namely

completing the existing outline. At this stage, the Draft 1 teaching media was validated by eight experts, consisting of 4 lecturers and four senior teachers. The instrument used at this stage is a validation questionnaire. The results of the questionnaire that the experts had filled in were then analyzed using the CVI score analysis with the formula:

$$CVI = \left(\frac{\Sigma s}{n(c-1)}\right) \text{ where is } s = r - l$$

description:

r : respondent score
l : lowest respondent score
n : number of respondents
c : highest category
CVI : Content Validity Index

Science Teaching Media as Draft 1 is declared feasible if it has a high (≥ 0.8) or medium (0.4≤CVI<0.8) CVI.

The fourth stage, namely the implementation stage, aims to help students achieve competence and ensure that students have the necessary competencies, attitudes, and abilities at the end of learning. The steps for making Canva media on conventional biotechnology material are as follows: open the Canva website or application (www.canva.com) and log in; select the appropriate design type, i.e., Presentation; choose a template that matches the theme of the project (for example, a science or food-themed template); change the title and text according to the material; add slides if you want to complement the material; add visual elements according to the material; add animations and transitions to make it enjoyable; preview the Presentation to make sure the template design is as desired; download the Presentation in PDf or Powerpoint (PPTX) file format; share the Presentation on the platform. The fifth stage is the evaluation stage, which includes activities to determine evaluation criteria, select evaluation tools, and conduct evaluations. At this stage, learning activities for conventional biotechnology material are carried out using Canva teaching media in experimental classes and control classes using books and PPT media. The research design used was a Pre-test and Post-test Nonequivalent Control Group Design. The effectiveness test used two classes: experimental and control classes. The research design is presented in Table 1

Table 1. Research Design

Group	Pre-test	Variable	Post-test
Control	Y_1	-	Y_2
Experiment 1	Y_1	X_1	X_1 Y_2
Experiment 2	Y_1	X_2	X_2 Y_2

Description:
Y_1: Pre-test score
X_1: Application of PPT Based on PjBL – STEM
X_2: Application of Canva PjBL – STEM Media
Y_2: Post-test score of critical thinking of students in the control class
X_1Y_2: Post-test score of critical thinking of class students with the application of PPT Based on PjBL – STEM
X_2Y_2: Post-test score of critical thinking of class students with the application of Canva Teaching Media Based on PjBL – STEM

The population in this study were phase D students of SMP Negeri 3 Baureno, Bojonegoro Regency, and the research sample was conducted in classes 9A, 9B, and 9C. Data collection in this study used test and non-test techniques. The test technique was written for students using long descriptions to measure their critical thinking skills. Non-test techniques are carried out using observation sheets to measure the implementation of learning activities by each learning model for each research sample. The instruments used in research on the development of Canva teaching media based on PjbL with the STEM approach to improving students' critical thinking skills must be tested first to

test the validity, item reliability, difficulty index, and question differentiator using Winstep software. The effectiveness test of Canva teaching media based on PjbL with the STEM approach to improving critical thinking skills was carried out using Rasch model analysis and SPSS. Pre-test and post-test data were analyzed using Rasch to determine the logit person value, then analyzed using the SPSS Anacova test and t-test. Before conducting the Anacova test, a prerequisite test is carried out, namely the normality and homogeneity test.

RESULTS AND DISCUSSION

This development research has produced a product in the form of PjbL-based Canva teaching media with a STEM approach. The development results are in accordance with the ADDIE development stage.

Results

The first stage is the analysis stage, which uses the observation technique of a questionnaire. The results of initial observations using a teacher needs questionnaire can be seen in Figure 1.

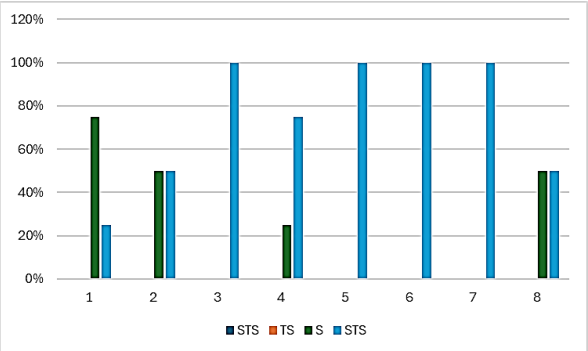

Figure 1. Results of teacher needs questionnaire

Description:
STS : Strongly Disagree
TS : Disagree
S : Agree
STS : Strongly Agree

Figure 1 shows that 25% of teachers and 75% strongly agreed with developing teaching media through PjBL-based Canva with a STEM approach. Based on the results of interviews, teachers stated that teaching media is needed, especially in learning in this era.

The results of the initial observation of student needs can be seen in Figure 2.

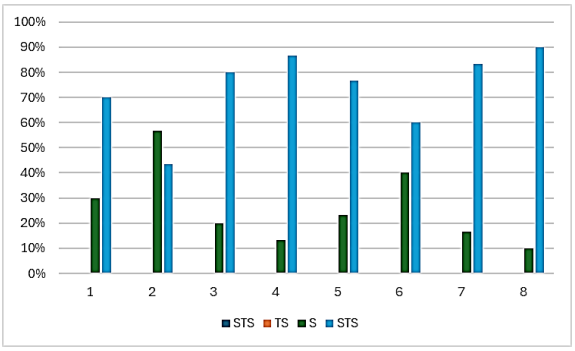

Figure 2. Results of student needs questionnaire.

Description:
STS : Strongly Disagree
TS : Disagree
S : Agree
STS : Strongly Agree

Figure 2 shows that, on average, 26% of students agree, and 74% strongly agree with the existence of PjBL-based Canva teaching media with a STEM approach.

At the design stage, researchers create designs through Canva media based on project-based learning and the STEM approach to conventional biotechnology material. The designs in question are as follows: cover, on the cover there is the title of the material, pictures of conventional biotechnology products, and the author's identity; learning objectives; basic principles of conventional biotechnology; definition of conventional biotechnology; steps for making tempeh; problems that arise in making tempeh.

The development stage comprises product content creation activities, guide development, and validation. Product content creation activities are preparing product content based on or following the initial design, learning objectives, tasks, and

learner evaluation. The cover of the developed teaching materials is shown in Figure 3.

Figure 3. Teaching media cover design

The cover contains the title, author's name, and illustrative images with themes that match the module's content, while the opening section consists of learning objectives.

The teaching material consists of several parts, namely material, STEM integration, projects, and evaluation, as shown in Figure 4.

Figure 4. Material content

The info presented also contains illustrative images that match the context of the info.

The next core learning activity is learning activities with PjBL syntax. The teaching materials developed aim to help students learn with the PjBL model. This means there are learning activities in the teaching materials following the syntax of PjBL. The project in the teaching module can be seen in Figure 5.

Figure 5. Student's worksheet content

In each learning activity, students are invited to determine the project they will do with the learning objectives determined at the beginning and the product produced at the end of the learning activity.

Expert judgment is a technique to validate or assess the feasibility of product design. Validators validated the results of the initial draft. Validators in this study include material experts, media experts, learning experts, and linguists. The results of the material expert validation can be seen in Table 2.

Table 2. The material expert validation result

Aspect	CVI Score	Criteria
accuracy of content	1,00	high
depth of material	0,93	high
clarity of Presentation	0,86	high
suitability for the curriculum	0,96	high
average	0,94	high

The results of the material expert validation showed an average CVI score of 0.94 and was included in the high category.

The results of media expert validation can be seen in Table 3

Table 3. Media expert validation result

Aspect	CVI Score	Criteria
media design	0,81	high
language use	0,92	high
visual display	0,81	high
ease of use	0,92	high
compatibility with learning objectives	0,94	high
average	0,88	high

The results of media expert validation show that the teaching materials developed

obtained an average CVI score of 0.867 and are in the high category.

The results of learning expert validation can be seen in Table 4.

Table 4. Learning expert validation result

Aspect	CVI Score	Criteria
Media design	0,81	high
Language use	0,92	high
Visual display	0,81	high
Ease of use	0,92	high
Suitability to learning objectives	0,94	high
Average	0,88	high

The results of learning expert validation obtained an average CVI value of 0.88 and were included in the high category.

The results of critical thinking skills expert validation can be seen in Table 5.

Table 5. Critical thinking skills expert validation result

Aspect	CVI Score	Criteria
validation of narratives/case studies	0,86	high
validation of instrument items	0,85	high
average	0,86	high

The results of the critical thinking skills expert validation obtained an average CVI value of 0.86 and were included in the high category. The experts agreed that the teaching media could be used without revision.

The validity test of the instrument questions using the RASCH model with the help of the Winstep program. Validity test results can be seen in Table 6.

Table 6. Validity test results

Question Number	MNSQ	ZSTD	COUR	Criteria
3	0,98	-0,6	0,59	valid
4	1,24	1,41	0,63	valid
5	1,23	1,33	0,39	valid
8	1,17	1,05	0,46	valid
9	1,07	0,49	0,61	valid
10	0,93	-0,35	0,56	valid
1	0,92	-2,07	0,35	invalid
2	0,7	-2,79	0,12	invalid
6	0,71	-2,31	0,24	invalid
7	0,82	-2,15	0,31	invalid

In Table 6, it can be seen that there are six valid questions and four invalid questions. This means that in the broad scale test, the questions used as instrument questions consist of 6 questions. The feasibility of instrument questions must be tested with a reliability test before being used in a broad-scale test. The reliability test results using the Winstep program obtained a reliability score of 0.84 and were included in the "Good" category.

The results of the test of the differential power of the questions can be seen in Table 7

Table 7. The differential power test result

Question Number	*Model S.E.*	Criteria
1	0,18	Good
2	0,18	Good
3	0,18	Good
4	0,18	Good
5	0,18	Good
6	0,18	Good
7	0,18	Good
8	0,18	Good
9	0,18	Good
10	0,18	Good
H Person Score	3,24	
H Item Score	0,33	

The results of the test of differential power show that question items 1 to 10 are included in the good criteria. The H Person value obtained is 3.24, rounded to 3. This means that the instrument question can distinguish participants' abilities into 3, namely high, medium, and low. The H Item value obtained is 0.33, rounded to 0. This indicates that the instrument question cannot distinguish good students.

The broad-scale test was conducted to determine the effectiveness of PjBL-based Canva teaching media with a STEM approach to students' critical thinking skills. The average score of the broad-scale test results can be seen in Table 8.

Table 8. Sample average score

Group	Average Score	
	Pre-test	Pos-test
control	55	64
experiment 1	59	69
experiment 2	59	78

From Table 8, it can be seen that the average value of the experimental class is better than the control class. Experimental class 2, which uses PjBL-based Canva teaching media with a STEM approach, has the highest average value compared to the control class and experimental class 1, which uses PowerPoint teaching media. These results prove that STEM-based Canva teaching media can improve students' critical thinking skills.

The effectiveness test value for using PjBL-based Canva teaching media with a STEM approach can be seen in Table 9.

Table 9. The effectiveness test result

Test	Sig	Conclusion
normality test	0,199	normal
homogeneity test	0,934	homogeny
ANCOVA test	0,000	significant
t-test	0,025	significant

The normality and homogeneity test results show that the mean scores of the experimental and control classes are normally distributed and homogeneous. The ANCOVA test showed significant differences in critical thinking skills in the experimental and control classes.

The results of critical thinking skills can be seen in Table 10.

Table 10. The results of critical thinking skills

Indicator	Critical Thinking Skills Score			
	Experiment Class	Criteria	Control Class	Criteria
Focus	93	Excellent	79	Good
Reason	86	Excellent	72	Good
Inference	84	Good	67	Enough
Situation	82	Good	60	Enough
Clarity	75	Good	55	Lack
Overview	63	Enough	53	Lack

Table 10 shows that in the experimental class, the focus and reason indicators have the highest score with excellent criteria, while the overview indicator has the lowest score with sufficient criteria. In the control class, the focus and reason indicators were included in the good criteria, while the clarity and overview indicators scored lack.

Evaluation of the implementation of Canva teaching media shows the advantages and disadvantages contained in Canva teaching media. The advantages and disadvantages of Canva teaching media can be seen in Table 11.

Table 11. Pros and Cons of PjbL-based Canva Teaching Media with STEM approach

Advantages	Disadvantages
1. Attractive & Interactive Visuals a. Canva provides creative templates that make it easy for teachers to create visual teaching media (infographics, presentations, videos) so that they are more interesting and motivating for students. b. Images, diagrams, and animations help	1. Dependence on Connectivity and Devices Requires internet access and adequate devices, which may be a constraint in remote areas

Advantages	Disadvantages
understand STEM concepts concretely.	
2. Encourages Collaboration Canva's collaboration feature allows students to work in teams to complete PjBL projects, practicing communication and cooperation skills.	2. Lack of Depth in STEM Content Canva focuses more on visual design rather than simulations or hands-on experiments, so it may lack depth for complex STEM concepts (e.g., programming or physical engineering)
3. Contextualized STEM Integration a. The STEM approach in PjBL integrates science, technology, engineering, and math in an integrated way, encouraging students to solve real problems. b. Canva helps with data visualization and solution prototyping (e.g., eco-friendly product design)	3. Potential Distraction Students may focus too much on the aesthetics of the design rather than the content and critical thinking process in the project.
4. Enhancing 21st Century Skills a. The project creation process in Canva trains critical thinking, creativity, and digital literacy. b. Students learn to analyze, evaluate, and reflect on project results.	4. Limitations of Data Analysis Features Canva lacks data analysis tools (such as spreadsheets or modeling software) that are often needed in STEM projects.
5. Easy & Flexible Access Canva can be used online/offline, making hybrid or self-paced learning easy.	5. Teacher/Student Training Required Not all teachers or students are accustomed to using Canva optimally for PjBL-STEM, requiring adaptation time.
6. Quick Feedback Teachers can provide immediate evaluation through comments or design revisions, improving students' critical thinking process.	6. Subjective Critical Thinking Evaluation Critical thinking skills assessment in Canva projects can be difficult to measure objectively without a clear rubric.

The existence of deficiencies in the use of PjbL-based canva teaching media with a STEM approach can be overcome with several solutions such as: combine Canva with other STEM tools (Tinkercad, PhET Simulation, or Arduino) for more in-depth experiments; Use authentic assessment rubrics to measure critical thinking processes (such as problem analysis, creative solutions, and reflection); Provide an offline alternative (design print) if internet connection is limited.

Discussion

The development of teaching media in this study used the ADDIE development model (analyze, define, design, implementation, and evaluation). At the analysis stage, data were obtained that most teachers stated that they strongly agreed with the development of teaching media through PjbL-based Canva with a STEM approach. Based on the results of interviews, teachers also stated that teaching media is needed,

especially in learning in this era. Irmansyah & Qaaf (2023) stated that media is equipment that can help teaching and learning activities. Therefore, a teaching medium is needed that can increase transmission speed and increase learning efficiency, expand storage capacity and facilitate long-term learning; increase compatibility and reduce the learning preparation process, but also pay attention to the negative impact of its spread on student attention in the classroom (Wang, 2021).

The results of initial observations of students obtained information that most students stated that they strongly agreed with the existence of PjbL-based Canva teaching media with a STEM approach. This is followed by the statement of Hanifah et al. (2020) that the use of biology learning media in terms of teaching media used by students is currently in the form of books that tend to contain long descriptions, few pictures, and colors displayed, so that students are less interested in reading them.

At the design stage, researchers create designs through Canva media based on project-based learning and the STEM approach to conventional biotechnology material. The designs in question are as follows: cover, on the cover there is the title of the material, pictures of conventional biotechnology products, and the author's identity; learning objectives; basic principles of conventional biotechnology; definition of conventional biotechnology; definition of fermentation; steps for making tempeh; problems that arise in making tempeh.

The development stage consists of product content creation activities, guide development, and validation stage. Product content creation activities are the process of preparing product content based on or in accordance with the initial design, learning objectives, tasks, and learner evaluation. The cover contains the title, author's name, and illustrations with themes that match the content of the module, while the opening section consists of learning objectives. The teaching material content consists of several parts, namely material, STEM integration, projects, and evaluation. The info presented also contains illustrative images that match the context of the info. Harahap et al. (2021) stated that using illustrations in teaching materials is adapted to reading skills and related to the material so that students are more motivated to read and that reading literacy skills can increase.

The next core learning activity is learning activities with PjbL syntax. The teaching materials developed aim to help students learn with the PjbL model. This means, in the teaching materials there are learning activities that are in accordance with the syntax of PjbL. The results of initial observations show that during learning activities, students' activities only pay attention to the teacher who explains the material presented. This is because learning resources are still limited to books, LKPD, and the teacher himself. Learning activities do not seem to make students active and train students' critical thinking skills.

Learning activities during this study showed that the PjBL-STEM approach packaged in Canva teaching media was able to increase students' engagement and understanding of biotechnology material, while developing critical thinking, collaborative and problem-solving skills. Learning becomes more meaningful because students are directly involved in the process of designing and simulating projects that are contextual to everyday life. The teacher's response was also positive after seeing the changes that occurred in students both in motivation, ability to work together, and critical thinking skills.

Learning activities that took place during the research, in accordance with the

Panjaitan's (2022) statement that the PjBL learning model can be interpreted as a project-based or product-based learning model. The PjBL learning model provides many opportunities for students to choose topics, investigate, and complete their projects when applied in practice, gaining knowledge through projects as a learning tool as if there is a real world that can produce products realistically, where students work realistically (Zulyusri et al., 2023).

Expert judgment is a technique to validate or assess the feasibility of product design. Validators validated the results of the initial draft. Validators in this study include material experts, media experts, learning experts, and linguists. The results of the material expert validation showed an average CVI score of 0.94 and was included in the high category. This shows that the teaching materials developed have met the eligibility requirements regarding content accuracy, depth of material, clarity of Presentation, and conformity with the curriculum. The material presented in the teaching materials can meet the learning objectives of the Science Learning Outcomes.

In the aspects of material depth and clarity of Presentation, teaching materials have met the eligibility requirements because the material presented remains focused on learning objectives so that students will not feel confused in learning activities with the PjBL model. In conformity with the curriculum, the material presented follows the times and is in the environment around students. This makes students feel that learning science subjects is theoretical and applied to daily activities. Project-based teaching materials can provide active and engaging learning activities, help students understand teaching materials well, and form critical and creative thinking skills in dealing with real environmental problems (Izzania et al., 2021).

The results of media expert validation show that the teaching materials developed obtained an average CVI score of 0.867 and are in the high category. This shows that the teaching materials developed have met the requirements of learning unit presentation techniques, completeness of Presentation, size, cover design, and learning content design, which are categorized as suitable for use. This follows the statement of Sunarsih & Yuliyanti (2021) that the feasibility of graphics in teaching materials reflects the content of teaching materials so that it must be displayed in detail to match the title and harmony of layout in the parts of teaching materials considered some parts must be labeled to make it easier for readers. Good learning design will affect the effectiveness of learning. Therefore, learning media must meet standards to help students better understand the material and make learning more enjoyable (Pattaufi et al., 2023).

The results of learning expert validation obtained an average CVI value of 0.88 and were included in the high category. The experts agreed that the teaching materials could be used without revision. This shows that the teaching materials developed have met the requirements of learning content, learning strategies, learning evaluation, and assessment. Rokhim et al. (2020) stated that PjBL is a learning model that integrates problem-based learning and project-based solutions where projects are affective, cognitive, and psychomotor improvement solutions. Therefore, learning aspects must be fulfilled so that evaluation and assessment of learning can be carried out.

The results of the critical thinking skills expert validation obtained an average CVI value of 0.86 and were included in the high category. The experts agreed that the

teaching media could be used without revision. This shows that the teaching media developed has met the requirements to improve students' thinking skills. The results of the instrument question validation test obtained 6 valid questions and 4 invalid questions. This means that in the broad scale test, the questions used as instrument questions consist of 6 questions. The feasibility of instrument questions must be tested with a reliability test before being used in a broad-scale test.

The results of the reliability test using the Winstep program obtained a reliability score of 0,84 and included in the “Good” category. The results of the item analysis test of the instrument became the basis for taking trial questions as many as 6 questions that were eligible to be used as test instruments. In the broad scale test, the number of questions used amounted to 6 questions. The results of the test of differential power show that question items 1 to 10 are included in the good criteria. The H Person value obtained is 3,24, rounded to 3. This means that the instrument question can distinguish participants' abilities into 3, namely high, medium, and low. The H Item value obtained is 0,33, rounded to 0. This indicates that the instrument question cannot distinguish good students. In compiling an exam script, items with a balanced difficulty level should be used with the criteria for questions in the difficult category as much as 25%, the medium category 50%, and the easy category 25% (Fatimah & Alfath, 2019).

The effectiveness of teaching media canvas media based on the PjbL model with a STEM approach to improving students' critical thinking skills can be seen from the average post-test scores and the results of the ANCOVA test and t-test. The average value of the experimental class is better than the control class. Experimental class 2 which uses PjbL-based Canva teaching media with a STEM approach has the highest average value compared to the control class and experimental class 1 which uses PowerPoint teaching media. These results prove that STEM-based Canva teaching media can improve students' critical thinking skills. This is because when people think critically, they evaluate the outcomes of their thought processes, calculate how good a decision is, or identify how effectively a problem has been solved (Shieh & Hsieh, 2021).

The normality and homogeneity test results show that the mean scores of the experimental and control classes are normally distributed and homogeneous. The ANCOVA test showed significant differences in critical thinking skills in the experimental and control classes. Experimental class 1 using PjBL-based Canva teaching materials with a STEM approach significantly improved students' critical thinking skills. PjBL-based Canva teaching media with a STEM approach is one of the teaching media that can be used anytime and anywhere. This result is also in accordance with Fitriyah's research which shows that PjBL-based STEAM learning has a significant effect on students' critical thinking skills, because the integration of STEAM PjBL together can be a learning innovation that can bring up creative and critical ideas and solutions, making it easier to solve a problem (Fitriyah & Ramadani, 2021). Cheerapakorn et al. (2024) state that Project-Based Learning is a learning method that emphasizes acquiring skills necessary for life in the 21st century by providing learners with opportunities to solve problems and address societal needs through accessible and practical projects. Project-based learning activities consist of several independent and related activities. At the same time, learners can constantly discover and solve problems in activities and

gradually cultivate their practical and problem-solving abilities to realize the concept of STEM education better (Yang et al., 2024).

The learning results using PjbL-based Canva teaching media with a STEM approach on the critical thinking skills of experimental class students on the *focus* indicator obtained a score of 93 and was included in the "Excellent" category while the control class obtained a score of 79 and was included in the "Good" category. This shows that the PjbL-based Canva teaching media with a STEM approach is able to enable students to improve their ability to formulate specific questions from STEM-based problems and clearly define project objectives. This result is in accordance with the results of Wahyuni's research which shows that STEM-based learning can improve science learning outcomes (Wahyuni, 2021). Gandi's research results also show that showed that the implementation of project-based learning lesson integrated STEM affected towards student's critical thinking skill (Gandi et al., 2021).

In the *reason* indicator, experimental class students obtained a score of 86 and were included in the "Good" category while the control class obtained a score of 72 and was included in the "Good" category. This shows that the PjbL-based Canva teaching media with a STEM approach is able to get learners to present logical reasons for project solutions and link arguments with facts/data. In the *inference* indicator, students in the experimental class obtained a score of 84 and were included in the "Good" category while in the control class obtained a score of 67 and were included in the "Good" category. This shows that the PjbL-based Canva teaching media with a STEM approach is able to enable students to conclude from the project results to identify assumptions and biases in the analysis. These results are followed by Alsaleh (2020) statement that when people think critically, they evaluate the results of their thinking process, calculate how good a decision is, or identify how effectively a problem has been solved.

In the situation indicator, experimental class students obtained a score of 82 and were included in the "Good" category, while the control class obtained a score of 60 and was included in the "Lack" category. This shows that the PjbL-based Canva teaching media with a STEM approach is able to make students understand the context of STEM problems and use key terms appropriately. In the clarity indicator, experimental class students scored 75 and were included in the "Good" category while the control class scored 55 and were included in the "Lack" category. This shows that the PjbL-based Canva teaching media with a STEM approach is able to make students explain ideas clearly, using visualizations that are easy to understand. The positive impact of applying the PjbL model on students' critical thinking skills, includes requiring students to participate in constructing and organizing knowledge directly, considering alternative answers, engaging directly in research and data analysis, and communicating directly with the community (Irdalisa et al., 2024). Susetyarini et al. (2019) also stated that with the application of project-based learning, students are trained to be able to communicate their opinions proficiently and become reliable problem solvers. In the overview indicator, experimental class students scored 63 and were included in the "Good" category, while the control class scored 53 and was included in the "Lack" category. This shows that PjbL-based Canva teaching media with a STEM approach is able to make students reflect on the process

and results of the project and evaluate the weaknesses/strengths of the solution. From this discussion, it can be concluded that Canva teaching media based on PjbL with a STEM approach can improve students' critical thinking skills.

CONCLUSION

Based on research on the development of PjBL-based Canva teaching media with a STEM approach to improving students' critical thinking, the characteristics of teaching materials include: can be accessed via smartphones anywhere and anytime, has a PjBL learning syntax, and contains learning with a STEM approach the results of the validity test show that the teaching media developed are valid and suitable for use. The results of the effectiveness test of PjBL-based Canva teaching media with a STEM approach proved significant and effective in improving students' critical thinking skills.

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