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Development of an Electronic Student Worksheet Integrating Project Based Learning on Biotechnology to Enhance Psychomotor Learning Outcomes of Grade XII Students

Suanna Madear Permatasari Sipayung*

Biology Education Study Program, Faculty of Mathematics and Natural Science, Medan State University

**suannamadear345@gmail.com* *(Corresponding Author)*

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ABSTRACT

This study is motivated by several issues, namely the low interest of students in biotechnology, the lack of understanding of basic concepts of biotechnology among students, the difficulty of implementing biotechnology practicum directly in schools, and the absence of E-Student Worksheets used in biotechnology materials by teachers. The purpose of this study is to determine the feasibility and effectiveness of an E-Student Worksheet based on project based learning on biotechnology material. The method employed in this study is research and development, with the developed product being an E-Student Worksheet based on PJBL on biotechnology material using the ADDIE model, which consists of five stages: Analyze, Design, Development, Implementation, and Evaluation. The results indicate that product validation by material experts achieved a percentage of 80.00% in the feasible category, while validation by media experts reached 82.5% in the very feasible category. Teacher responses to the product showed a percentage of 86.66% in the very good category, and student responses yielded 87.73% in the very interesting category for the individual trial, 90.18% in the very interesting category for the small group trial, and 92.55% in the very interesting category for the limited group trial. The effectiveness of the E-Student Worksheet was obtained with a percentage of 92.21% in the very effective category. In conclusion, the E-Student Worksheet based on project-based learning on biotechnology material can be used to improve students' psychomotor learning outcomes.

INTRODUCTION

Biology encompasses direct and meaningful learning experiences aimed at helping students develop a better understanding of their environment. There are three main aspects in biology education: scientific attitudes, scientific processes, and scientific products. Beyond merely understanding concepts, it is essential for biology education to provide direct experiences in mastering scientific processes, products, and attitudes, as well as in developing scientific literacy more broadly (Budiarti & Oka, 2014). When taught to students, science process skills including cognitive, psychomotor, and social skills enhance the significance of science education (Nugraha et al., 2017). Practical activities serve as an effective means to train science process skills. One important component of teaching and learning activities is practical work, which can assist in discovering certain principles or providing explanations for principles being studied. Practicals help transform tools and materials that were previously considered abstract into more concrete and understandable forms (Sastria et al., 2020).

Project-based learning can be applied in practical contexts. (Riza et al., 2020) emphasizes that this method provides students with opportunities to complete tasks and gather knowledge relevant to everyday life. Through this approach, students gain various experiences, information, skills, and attitudes. They can overcome challenges, develop critical thinking abilities, become more

independent in their learning process, and gain a deeper understanding of concepts while working on projects.

Conventional biotechnology learning focuses on a project-based approach. Research by (Ladyana, 2014) indicates that biotechnology can be applied through projects involving the creation of products such as tempeh, yogurt, and kombucha. By engaging in collaborative learning, students become more involved and actively work together in groups. The successful implementation of biotechnology practicals requires a well-defined and structured practical guide. With an organized and unambiguous guide, students can understand the objectives of the practical sessions and the necessary steps to take. E-Student Worksheet is educational material presented in a digital format, containing information, summaries, and instructions to complete the assigned learning tasks (Setiawan & Indana, 2021). The selection of learning media should align with students' preferences to enhance their interest in learning and develop their thinking skills (Surata et al., 2020). The E-Student Worksheet can serve as a learning tool that is accessible anywhere. Therefore, more interactive E-Student Worksheet is needed so that students can easily access it in various locations. According to (Safitri et al., 2022), using the E-Student Worksheet can foster greater creativity and skills in students, as the E-Student Worksheet provides guidance to engage them in various activities related to skills and creativity. Through this approach, students can gain new knowledge and develop the creativity that needs to be mastered.

The Project Based Learning (PjBL) model is one of several learning approaches relevant to the development of E-Student Worksheet in biotechnology as an effective learning tool. According to (Kristanti et al., 2016), the PjBL model has the potential to teach students three key things: (1) expanding knowledge through authentic curricular activities; (2) building knowledge through real-world experiences in a collaborative environment; and (3) helping students learn meaningful knowledge and skills through authentic tasks and projects. According to research conducted by (Sumarni et al., 2016), project-based learning that centers on students is crucial and offers significant benefits for developing psychomotor skills. Practical work plays an important role in connecting lessons to daily life, enabling students to understand the material, apply the knowledge they have learned, and enhance their skills and psychomotor dexterity.

One of the creative activities in conventional biotechnology materials is the practicum of making kombucha. Kombucha is a fermented tea made from tea, sugar, and a symbiotic culture of bacteria and yeast (SCOBY). This drink is rich in probiotics and antioxidants, providing benefits such as improving digestive health, detoxifying the liver, reducing inflammation, lowering blood sugar levels, and strengthening the immune system. Through the kombucha-making practicum, students gained an understanding of the fermentation process involving yeast and bacteria, as well as hands-on experience in preparing ingredients and following the steps. They learn to evaluate the results of kombucha after 7 to 14 days of fermentation, observing characteristics such as flavor and aroma. This practicum also allows students to apply biology and chemistry concepts, and understand the role of microorganisms in food production. In addition, the skills acquired can open up opportunities to develop business ideas related to kombucha products in the future (Aini et al., 2022).

From the curriculum analysis on the biotechnology subtopic of conventional biotechnology applications, the learning objectives are designed so that students are expected to be able to conduct experiments related to conventional biotechnology and compile reports on the results of the experiment properly and systematically. In the learning process, the method used is a combination of theory in the classroom and laboratory practice, which provides students with the opportunity to apply the knowledge gained directly in a real environment. In this way, students not only understand the basic concepts, but also the fermentation process and the manufacture of biotechnology products such as tempeh, yogurt, kombucha and others. The learning resources used include package books. In addition, the assessment system includes project assessment, where students are asked to write down the results of their work through a structured trial report. This not only hone students' practical skills, but also their analytical abilities that are very important in the world of biotechnology.

Interviews with Biology teachers at State Senior High School 1 Tanjung Morawa revealed several challenges in teaching biotechnology. The teacher stated that students' interest in biotechnology is still low, even though understanding and skills in this field are very necessary in this day and age. In addition, teachers stated that students' lack of understanding of the basic concepts of biotechnology is one of the factors causing their low interest, as students do not seem to fully realize the importance of biotechnology in everyday life. The teacher also stated that biotechnology practicum is also difficult to implement directly at school, where limited facilities and adequate equipment prevent students from gaining practical experience that can strengthen their understanding. The teacher also stated that have not used E-Student Worksheet in the biotechnology learning process, even though the use of good E-Student Worksheet can help students understand the material in a more structured and systematic manner.

Based on the literature study, several problems were found in learning biotechnology. In a study entitled Analysis of Factors of Difficulties in Learning Biology for Biotechnology Material Students at State High Schools in Medan City by (Rahmadani et al., 2017) stated that there were student learning difficulties in biotechnology material from internal (interest, motivation, and talent) and external factors (teachers, labs, and books). External factors produce the largest percentage of 44% and internal factors produce a percentage of 43%. Interest is one of the factors causing learning difficulties from internal factors with a percentage of 44%, based on the results of this study most students answered questions about whether they liked biotechnology material or not, most students answered ordinary, this shows that students' interest in learning is in a low category.

Then the availability and use of biology laboratories is the highest external factor causing learning difficulties with a percentage of 49%, laboratories are included in learning tools, without learning tools the presentation of material becomes less perfect, especially for practicum material, the lack of laboratory equipment will cause many difficulties in learning. In addition, the external factor causing learning difficulties is the availability of student books with a percentage of 45%, based on the research results in the literature study, only some students receive book loans from the school. Most students generally find it difficult to understand when reading biotechnology material in textbooks/teachings, this is what reduces student interest in reading books related to biotechnology which causes low learning outcomes.

In another study with the title Analysis of Factors of Difficulty in Learning Biotechnology Materials in High School Students in Pematang Siantar by (Nasution et al., 2022) stated that the cause of the greatest learning difficulties was caused by external factors (including school facilities, learning media, and books) with a percentage of 41.23% and internal factors (talent, health, interest and motivation) of 39.49%. Learning media is the highest external factor causing learning difficulties at 15.12%. The use of learning media is very important in every learning material. The lack of use of learning media is the cause of learning difficulties for students, even though the implementation of learning media can make it easier for students and generate motivation, especially in learning abstract material.

Then the next highest learning difficulty is school facilities with a percentage of 14.33%. In this case the facilities in question are laboratories, the use of laboratories that are very rare due to the very small number of practicums is a cause for students to understand biotechnology material. Based on this research, it was found that students rarely use the laboratory during learning. The last learning difficulty factor is influenced by books with a percentage of 11.78%. Based on the results of this study, it was found that only a few students had handbooks and understood the material in the textbook. Internal factors causing learning difficulties have a percentage of 39.39%, one of which is the factor of student interest in learning biotechnology. Interest has a significant effect on student learning outcomes, when students' interest is strong in the lesson, good results will be obtained because students learn seriously.

In the research of (Zetkas et al., 2016) with the title Analysis of Students' Understanding and Learning Difficulties in Biotechnology Materials Throughout Padang Sidempuan City stated in the results of their research that there was a lack of understanding of the concept of biotechnology and students had difficulty learning the material where most students did not complete, namely from

331 students or as many as 180 students (54.38%). The development of e- student worksheet based on project based learnning is expected to provide the necessary structure for practice and observation, as well as create a more engaging learning experience. In addition, by utilizing technology, learner e-student worksheet can provide interactive learning media. Thus, the purpose of developing this student worksheet is to create effective and attractive media, which is able to improve students' understanding and psychomotor skills in conventional biotechnology, as well as support the achievement of competencies set out in the curriculum.

From the exposure of the results of several literature studies and analysis of problems found in schools from the results of interviews that there are problems and difficulties of students in learning biotechnology. Choosing E-Student Worksheet Project Based Learning on biotechnology material because Projects in PjBL can improve student skills or student psychomotor skills, this is important in preparing students to face the changing demands of the world of work especially in biotechnology material students can learn to make products either food or techniques in conventional biotechnology manufacturing. Based on this, research will be conducted on Development of an Electronic Student Worksheet Integrating Project Based Learning on Biotechnology to Enhance Psychomotor Learning Outcomes of Grade XII Students.

MATERIALS AND METHODS

1. Time and Place of Research

This research was conducted at State Senior High School 1 Tanjung Morawa which is located at JL. PSR VIII Batang Kuis No. 151, Buntu Bedimbar, Tanjung Morawa District, Deli Serdang Regency, North Sumatra. The time of this research will be carried out in July 2025-August 2025.

2. Research Method

The type of this study uses research and development methods. The product developed in this study is a E-Student Worksheet based on PJBL on biotechnology materials using the ADDIE model which consists of 5 stages, namely the Analyze, Design, Development, Implementation and Evaluation stages.

3. Population and Sample

The subjects in this study are 36 students of grade XII of State Senior High School 1 Tanjung Morawa. The research subjects are taken using the purposive sampling technique. The object of this research is the feasibility of E-Student Worksheet based on PJBL on the biotechnology materials through the requirements of feasibility and effectiveness.

4. Research Procedure

The research procedure for developing e-student worksheets in biotechnology consists of several stages. First, in the Analyze stage, the problem is defined through interviews with biology teachers and literature reviews to identify challenges in biotechnology learning. This includes problem analysis, needs analysis, and learning objectives analysis to determine the target audience and educational goals. Next, the Design stage involves creating the e-student worksheet, which includes instructional content, competencies, learning indicators, and multimedia elements, organized according to a project board. The Development stage focuses on producing the worksheet using a live website format, incorporating validation from experts to ensure product quality before testing it with students. During the Implementation stage, the worksheet is trialed with students in individual, small, and large group settings to assess its impact on psychomotor learning outcomes. Finally, the Evaluation stage reviews the effectiveness of the worksheets through assessments and feedback, aiming to improve future iterations of the material based on psychomotor skill outcomes.

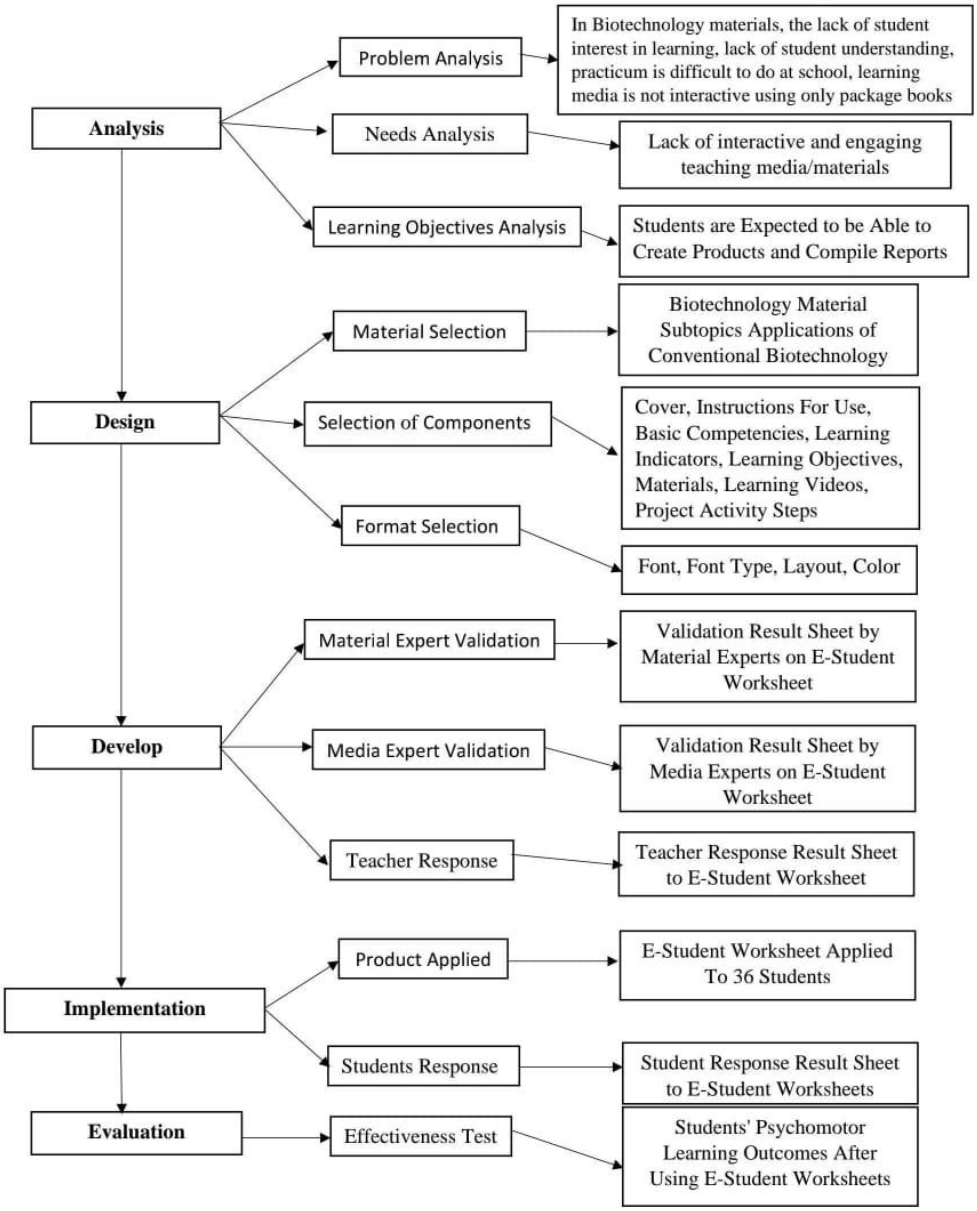


Figure 1. Flow of Research Procedure

5. Data Collection

The data collection technique in this study was used questionnaires and observation sheets for students' psychomotor assessments. Questionnaires are used to get an assessment of the quality of Student E-Student Workshees from material experts and media experts, in addition to questionnaires are used to get responses to Student E-Student Worksheet from teachers and students. Then, the psychomotor assessment observation sheet was used to obtain data on students' psychomotor learning outcomes after using the developed E-Student Worksheet.

6. Data Analysis

The data analysis that will be obtained in this study are quantitative and qualitative data. Quantitative data was obtained from the assessment scores of material experts, media experts and the results of teacher and student responses. Meanwhile, qualitative data is presented in descriptive form in the form of comments and suggestions given by validators, teachers, and students regarding the "E-Student Worksheet for Project Based Learning on Biotechnology Materials" that has been developed. The data analysis technique is divided into 2 parts, namely data analysis of the results of validation sheets of material experts and media experts and data analysis of the results of teacher and student response sheets developed in a summary list in the form of a Likert scale.

RESULTS AND DISCUSSION

The product that has been created is an E-Student Worksheet based on project-based learning which is used as a learning medium for biotechnology material, especially conventional biotechnology for making kombucha tea, to improve students' psychomotor learning outcomes. The E-Student Worksheet based on project-based learning is systematically and structured, containing materials, images, and videos that are in accordance with the results of the problem analysis and students' needs so that learning objectives can be achieved. E-Studentt Worksheet offers flexibility and ease of access that conventional Student Worksheet do not have, making it more suitable for learning in the digital era (Paspania & Susilawati, 2024). In the context of education, PJBL provides opportunities for students to explore various aspects of a project, from planning to evaluation of results. (Rais, 2010) stated that PJBL allows students to collaborate in groups, which not only improves their understanding of concepts but also their social skills. Thus, PJBL is an effective method to create a more immersive and meaningful learning experience for students.

From the problem analysis, it is known that students' interest in learning biotechnology material is low and students' understanding is still lacking in biotechnology material because there is no availability of interactive learning media. In addition, it is known from the results of the problem analysis that in the school, practicums are difficult to carry out at school so that learning that requires practice such as biotechnology is hampered. Therefore, interactive learning media such as E-Student Worksheet is very necessary in learning. This is in accordance with the opinion of (Chaniago, 2022) who stated that E-Student Worksheet has various features that can meet the learning expectations expected by students so that students' learning interests and understanding are met by using technology effectively so that interactive learning and with E-Student Worksheet teachers can prepare materials and assignments to be more interesting so that learning takes place well.

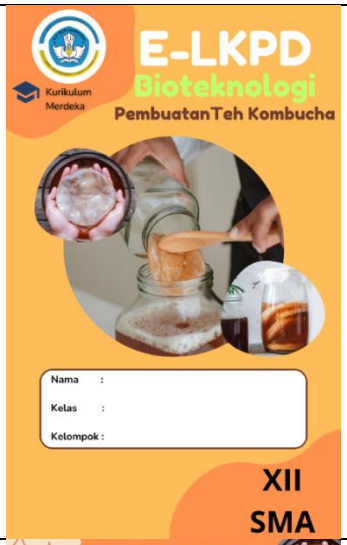
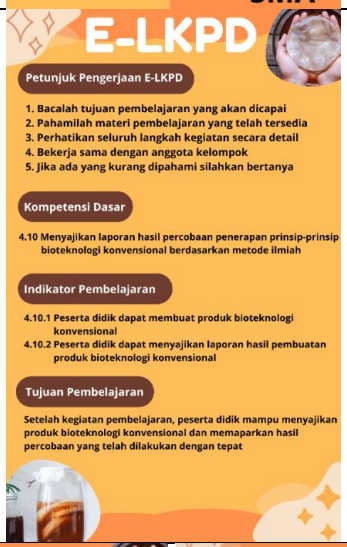
From the needs analysis, it is known that the internal factors of students' learning difficulties in biotechnology material are related to interest, motivation, and talent. Meanwhile, external factors are related to teachers, laboratories, and books. Learning that is less interesting will cause students to lose interest in the learning process and be less motivated to participate in learning. Likewise, when the facilities are inadequate, what happens is that talents are hidden. Similarly, when teachers only conduct one-way learning and do not involve students in learning and use the laboratory minimally, then the learning process is focused on textbooks that contain quite a lot of material and there are no learning media that support understanding in the learning process. This is in accordance with the opinion of (Miftah, 2013) who stated that media is a means of providing visual experiences to students that are useful in increasing learning motivation, clarifying and simplifying abstract concepts, and increasing student retention or absorption.

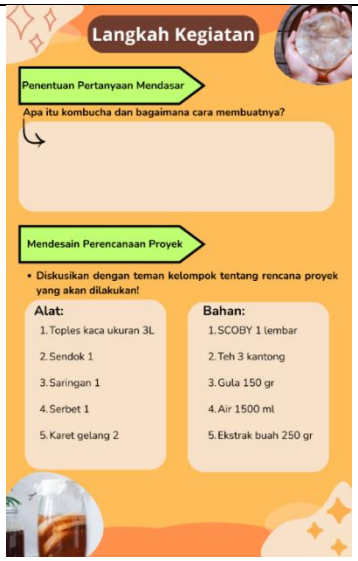
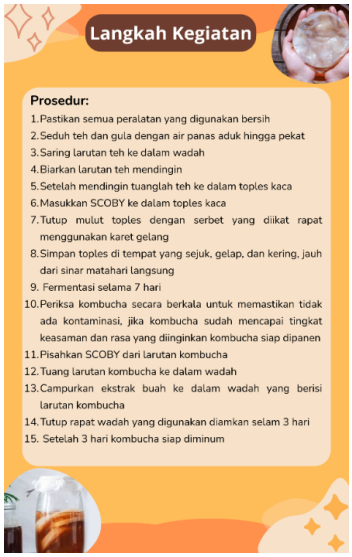
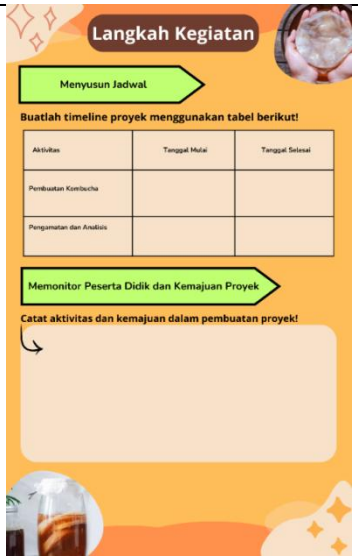
From the analysis of learning objectives, it is known that in biotechnology learning materials, especially conventional biotechnology, there are learning objectives that must be achieved by students through learning, namely students are able to conduct conventional biotechnology experiments and students are able to compile reports on the results of conventional biotechnology experiments. Based on these objectives, of course, in carrying out this learning in order to achieve the learning objectives, students need guidance in the learning process because in this case conventional biotechnology certainly makes products where the application of project-based learning models will be appropriate to be applied to the material. This is in accordance with the opinion of (Lestari & Rakhmawati, 2024) who stated that E-Student Worksheets based on project-based learning are important in biotechnology materials because they can improve student skills and make learning more interesting through real projects that are relevant to life. The use of digital media and project-based learning models allows students to develop a deep understanding of biotechnology through direct experience.

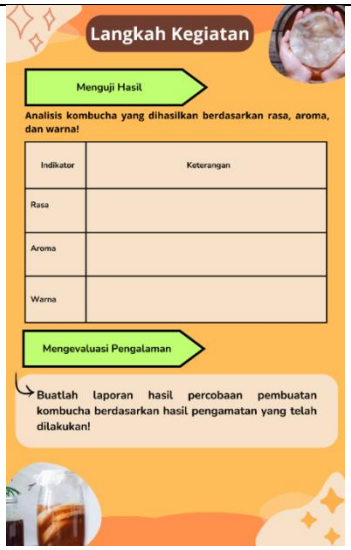
From the design stage, research design has been carried out starting with the creation of biotechnology materials, selecting components made in the E-Student Worksheet, determining the appropriate format, collecting images and videos that are appropriate to the learning materials that

will be included in the E-Student Worksheet. The E-Student Worksheet was designed using Canva and Live Worksheet. The developed product contains stages based on project-based learning on biotechnology materials. According to (Syarif, 2017) the stages of project-based learning consist of starting with essential questions, designing a plan for the project, creating a schedule, monitoring the students and the progress of the project, assessing the outcome, and evaluating the experience. The E-Student Worksheet that has been created can be seen in table 1.

Table 1. E-Student Worksheet Based on Project Based Learning on Biotechnology Materials

No.	E-Student Worksheet	Explanation
1		The front cover consists of the title of the student's e-worksheet and images related to biotechnology material (the project made), namely kombucha.
2		Instructions for the use of the Student E-Student Worksheet are made for teachers and students. The basic competencies, learning indicators, and learning objectives that are created are adjusted to the independent curriculum on biotechnology materials specifically for the subtopic of conventional biotechnology applications.
3	 	The learning materials and videos made are tailored to the learning subtopics.

No.	E-Student Worksheet	Explanation
4	 	The activity steps use a project-based learning syntax which consists of 6 stages, which are as follows; **Syntax Project Based Learning I** 1. Determination of Fundamental Questions Activity: The teacher introduces the topic and gives fundamental questions. Question: How can the fermentation process in kombucha make affect the aroma, taste, and color of the final product? **Syntax Project Based Learning II** 2. Design Project Planning Activity: - The teacher explains the tools and materials needed to make kombucha and ensures all the equipment has been brought by the students. - The teacher asks students to choose the kombucha flavor variant they want to make.
5		**Syntax Project Based Learning III** 3. Develop a Schedule Activity: The teacher directs the students to compile the date of creation Kombucha from start to finish. **Syntax Project Based Learning IV** 4. Monitor Students and Project Progress Activity: - The teacher directs the students to start making kombucha by following the steps that have been laid out. - The teacher supervises and provides guidance and answers questions.

No.	E-Student Worksheet	Explanation
6		**Syntax Project Based Learning V** 5. Testing Results Activity: - After the kombucha has been made for 7 days, the teacher asks the students to observe the color, aroma, and taste. **Syntax Project Based Learning VI** 6. Evaluate Experience Activity: The teacher asks each student to write a report on the results of the experiment that has been carried out.

Furthermore, the finished product will be tested for feasibility by the validator, while the things assessed by the validator are the material aspect and the media aspect. Validating the product is carried out so that the feasibility level of the E-Student Worksheet is known and getting suggestions and input from the evaluator and teachers to improve the quality of the E-Student Worksheet before it is implemented to students. The component of the assessment of subject matter experts consists of aspects of format, aspects of material content, and language aspects.

Table 2. Material Validation Results

Aspects	Indicator	Score	Percentages
Format	KD suitability, learning objectives and indicators	4	
	Suitability of the material to learning	5	90%
Content of the material	Clarity of presentation of material	4	
	Suitability of material with the project raised in e-student worksheet	4	
	Image and video compatibility	4	
	Conformity of material concepts and theories	4	80%
	The scope and depth of the material are in accordance with the learning objectives	4	
Language	Clarity of language use	4	
	Clarity of the structure of sentence usage	3	70%
Total Assessment Score			**36**
Maximum Score Total			**45**
E-Student Worksheet Quality Percentage (%)			**80%**
Category			**Feasible**

The E-Student Worksheet that has been assessed by the subject matter expert is declared worthy of revision according to the advice given by the subject matter expert. The details of the results are as contained in table 2. Based on the results of expert validation of the feasibility of the content of the E-Student Worksheet based on project-based learning on biotechnology materials consisting of format aspects including, aspects of material content, and language aspects in the E-Student Worksheet obtained an average score of 80% with a feasible category. The results were obtained after revising and improving the format, content of material presentation, and language. The suggestions given by the expert validator include paying attention to inappropriate word

writing, tidying up the writing format well, and adding material presentations related to the microbes involved in making kombucha as well as presenting explanations in the material related to the role of these microbes in the process of fermenting kombucha tea which makes the material even deeper so that learning is conveyed. This is in accordance with the opinion of (Widiansyah et al., 2024) stating that by facing real challenges, students feel more involved with the subject matter so as to increase their enthusiasm and involvement in learning.

Table 3. Media Validation Results

Aspects	Indicator	Score	Percentages
Readability Text	The language of the material text is easy to understand	4	86,6%
	Proportional font size and typeface	4	
	Text color contrasts with background	5	
Quality display and illustration	The drawings are in accordance with the material being studied	4	80%
Consistent Order Presentation of contents	Appropriateness of image and video size presentation	4	80%
	The layout of each page is balanced	4	
	Clarity of the instructions used in the e-student worksheet	4	
Settings layout (layout) of Fill	Placement of activity titles, activity sub-headings Learn clearly	4	70%
	Cover layouts and illustrations can provide Overview of the material to be presented at the e-student worksheet	3	
Project Based Learning	The order of content of the e-student worksheet is in accordance with the PJBL syntax	4	85,7%
	E-Student Worksheet present fundamental questions that encourage student exploration and discussion.	4	
	E-Student Worksheet provide clear guidance for designing project planning that students will undertake.	5	
	E-Student Worksheet includes the preparation of a structured schedule for the implementation of the project.	4	
	E-Student Worksheet provide a way to monitor students' progress in completing projects	4	
	E-Student Worksheet includes steps to test and evaluate the results of the project the student is working on	5	
	E-Student Worksheet encourage students to evaluate experiences and learnings gained during the project	4	
Total Assessment Scores			**66**
Maximum Total Score			**80**
Percentage of Quality of E-Student Worksheet (%)			**82,5%**
Category			**Very Feasible**

The media expert assessment components consist of text readability, display and illustration quality, consistency in content presentation, layout arrangement of content, and project-based learning. The details of the results are as shown in table 3. The results of media expert validation on the feasibility of E-Student Worksheet based on project based learning on biotechnology material showed an average value of 82.5% with a very feasible category. The value was obtained from an assessment of several aspects, including the readability of the text, the quality of the display and illustrations, the consistency of the order of presentation of the content, the layout of the content,

and the project based learning aspect. The results were obtained after revisions with improvements from the validator. The improvements made consisted of adding the Ministry of Education and Culture logo on the cover, aligning the writing on one line with another, using numbering tabs in the bullet points, improving the appropriate spacing between one sentence and another, making the kombucha making video tutorial larger so that it is not close to the bottom of the material, changing the writing from bold on the numbering to not bold, then adding the number and specific size for the tools and materials used in the project. The improvements provided by the validator make the developed product a suitable media for use by students in the learning process. This is in line with (Nuraini, 2005) that good learning media will activate learners in providing responses, feedback, and also encourage those being taught to carry out correct practices.

Table 4. Teacher's Response Results

Aspects	Indicator	Score	Percentages
Content Eligibility	The content of the e-student worksheet is in accordance with the basic competencies and objectives learning	4	80%
Linguistics	The use of language in the e-student worksheet is easy to understand	4	80%
	The words used are short and straightforward	4	
	Spelling used according to EYD	4	
Facilities	e-student worksheet is easy to use	4	80%
Presenting	e-student worksheet makes it easier for students to identify a problems through stages in the PJBL model	4	80%
Graphics	The font size on the e-student worksheet is proportional	5	100%
	The typeface used is easy to read	5	
	Attractive display design	5	
Total Assessment Score			**39**
Maximum Score Total			**45**
E-Student Worksheet Quality Percentage (%)			**86.66%**
Category			**Very Good**

The product of the development of learning media in the form of a project-based learning E-Student Worksheet was given to one of the teachers of biology in grade xii at State Senior High School 1 Tanjung Morawa. Furthermore, a perception questionnaire was given which was used to find out suggestions, comments, and assessments from teachers on the products developed before being implemented to students. The results of teacher assessments of the E-Student Worksheet are in table 4. The results of the assessment of teachers' responses to the developed product, namely the E-Student Worksheet based on project-based learning on biotechnology materials, showed an average score of 86.66% with the very good category. Media in the form of E-LKPD that obtains an assessment result of 80% or above is included in the very good category because it meets the criteria of validity, practicality, and high effectiveness in learning, as evidenced by student responses that reach 81.7% to 82.3% with that category (Az Zahra & Winarni, 2025). The use of this E-LKPD supports the achievement of learning completeness of at least 80% of students, making it an effective tool for a problem-based scientific approach (Rosalinda, Hamid, & Kusasi , 2022). In addition, validation by media experts often produces scores above 80% which is categorized as very good, so that E-LKPD is worthy of being developed and implemented widely in the classroom (Mariza & Ain, 2025) Based on this data, it can be concluded that the response from teachers to the E-Student Worksheet stated that the product developed was good from the assessment regarding the feasibility aspects of content, linguistic aspects, aspects of ease of use, aspects of presentation, and graphic aspects. This is in line with the opinion of (Ningtyas & Rahmawati, 2023) that the components of content, language, use, presentation and graphics that are simple and easy to understand and meet standards will be suitable for use in the learning process.

The implementation stage is the stage of product testing to the target subject, namely applying the product from development that has been validated and declared valid by the validator to the student who is the target subject. After the E-Student Worksheet has been declared valid by the validator and has received positive response results from the teacher, then the student is also asked to respond to the questionnaire to the E-Student Worksheet used. The product trials carried out on the ADDIE development model include student responses to the E-Student Worksheet on biotechnology materials. In the students, a 3-step trial was obtained, namely an individual group trial of 3 students, a small group trial of 10 students, and a limited group trial of 36 students.

Table 5. Percentage of Individual Responses to E-Student Worksheet

No	Aspect	Persentages	Criteria
1	Table of Contents Display	88,88%	Very Attractive
2	Serving Order	84,44%	Very Attractive
3	Language	90,00%	Very Attractive
Average		**87,73%**	**Very Attractive**

Table 6. Percentage of Small Group Responses to E-Student Worksheet

No	Aspect	Persentase	Criteria
1	Table of Contents Display	90,00%	Very Attractive
2	Serving Order	88,88%	Very Attractive
3	Language	91,66%	Very Attractive
Average		**90,18%**	**Very Attractive**

Table 7. Percentage of Limited Group Responses to E-Student Worksheet

No	Aspect	Persentages	Criteria
1	Table of Contents Display	92,59%	Very Attractive
2	Serving Order	90,92%	Very Attractive
3	Language	94,16%	Very Attractive
Average		**92,55%**	**Very Attractive**

The individual trial consisted of 3 students in grade xii. The assessment carried out includes aspects of display content, presentation order, and language. The average result of the percentage of individual responses can be seen in table 5. The small group trial consisted of 6 grade xii students. The assessment carried out includes aspects of display content, presentation order, and language. The average result of the percentage of small group responses can be seen in table 6. The limited group trial consisted of 36 grade xii students. The assessment carried out includes aspects of display content, presentation order, and language. The average result of the percentage of limited group can be seen in table 7. The results of the student response assessment during the individual product trial showed an average value of 87.73% with a very interesting category. The results of the small group product trial showed an average value of 90.18 with a very interesting category. Then the results of the limited group product trial showed an average value of 92.55% with a very interesting category. Based on these data, it can be concluded that students are interested in E-Student Worksheet based on project-based learning on biotechnology material reviewed from the aspects of content display, presentation sequence and language. This is in accordance with research by (Wijayanti et al., 2023) which concluded that students are interested in using E-Student Worksheet in learning activities where E-Student Worksheet is an interactive learning media containing learning materials, images, and videos that are packaged into one with an attractive content display, a media presentation sequence that makes it easy for students to use it, and language that is easy for students to understand.

Table 8. Data on Student Psychomotor Learning Outcomes

Number of Students	Total Psychomotor Learning Outcomes Score	Average
36	3,319.86	92,21

At the evaluation stage, the E-Student Worksheet was given to 36 grade xii students to be used in learning biotechnology materials for kombucha making. During the project activities and after the project activities are completed, students are observed and assessed using a psychomotor assessment observation sheet for biotechnology material practicum. The aspects assessed in student psychomotor are tools and materials, work steps, work attitudes, practicum results, and the ability to analyze work. Each aspect that is assessed has several indicators that are used to determine whether or not the aspect is fulfilled in the student. The results of the assessment of students' psychomotor learning outcomes can be seen in table 8. The effectiveness of the project-based learning-based E-Student Worksheet on biotechnology materials is seen based on students' psychomotor learning outcomes. The evaluation stage was carried out on 36 grade xii students. Based on the results of the calculation of psychomotor assessment scores for all students, it shows good learning completeness with an average score of 92.21% with a very good category. These results show that the use of project-based learning-based E-Student Worksheet is effective in improving students' psychomotor skills about biotechnology, especially conventional biotechnology in making kombucha. The results of the study showed an increase in psychomotor learning outcomes after using the project-based learning-based E-Student Worksheet on biotechnology materials. This happens because the learning process is equipped with interesting learning media and stimulates students' interest in reading. This is in accordance with the statement of (Arsyad, 2013) stating that media that has met the aspects of effectiveness and efficiency will certainly increase students' interest in learning and support learning achievement so that the material delivered through this media will also be easier to absorb by students.

CONCLUSION

The conclusion is that the development of the E-Student Worksheet based on project-based learning in biotechnology materials was conducted using the ADDIE method, resulting in a worksheet that is feasible and effective for improving students' psychomotor learning outcomes. Evaluations from subject matter experts indicated that the E-Student Worksheet is in the feasible category with a percentage of 80%, while assessments from media experts categorized it as very feasible with a percentage of 82.5%. Teacher responses to the E-Student Worksheet showed an excellent category with a percentage of 86.66%, and student responses indicated a very interesting category, with percentages of 87.73% in individual trials, 90.18% in small group trials, and 92.55% in limited group trials. Additionally, effectiveness tests revealed that the E-Student Worksheet is effective in enhancing the psychomotor learning outcomes of XII grade students, achieving a very effective category with a percentage of 92.21%. As a follow-up to this research, it is suggested that teachers use the project-based learning E-Student Worksheet on biotechnology materials as an alternative learning media in the teaching and learning process in schools. For students, this E-Student Worksheet can serve as a learning medium that helps them understand biotechnology materials, such as conventional biotechnology in making kombucha, and provides new experiences in the learning process. Additionally, for future researchers, it is necessary to develop project-based learning E-Student Worksheets for other materials with different projects according to the needs of students.

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