

Implementation of Augmented Reality in the Development of Bioentrepreneurship-Based LKPD for Visualization of Fungi Material in High School

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Abstract

The digital era demands educational transformation with relevant learning methods to prepare students to face the world of work. This study developed a Student Activity Sheet (LKPD) based on bioentrepreneurship assisted by Augmented Reality (AR) on fungi material. The aim is to encourage students' creativity and innovation and improve the quality of learning. The research method uses the R&D model with the define, design and develop (3D) stages. This research was conducted in one of the high schools in Ternate City. The research subjects consisted of three expert validators and 15 class X IPA students. The results of the study showed that the LKPD developed was very valid and feasible to use, and effectively improved the quality of student learning on fungi material in high schools.

Keywords: student activity sheet; bioentrepreneurship; fungi material; creativity; innovation; visualization

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1. Introduction

Current curriculum developments have focused students on a local approach to the community and surrounding environment so that when students complete their education at the Senior High School (SMA/MA) level they will be able to live independently and be able to adapt various uses of technology related to current learning. (Muzakki, 2024; Zebua, 2024; Ramadhaniyati, Subekti & Acheampong, 2024). As the digital era continues to develop, the world of education is facing new challenges that require adjustments in teaching methods and curricula. One of the current issues in the field of education is the need to develop 21st century skills, which include critical thinking, creativity, communication, collaboration and entrepreneurial skills. Education no longer only focuses on mastering academic material, but also on developing competencies that are relevant to the needs of a dynamic job market and demand teacher innovation in designing learning related to the content of biological material implemented during learning (Adiyono, Hayat, Oktavia, & Prasetyo, 2024 ; Aditya & Suranto, 2024; Gresinta & Tukiran, 2024).

Biology is a subject that has great potential to be developed in an entrepreneurial context, especially through the topic of fungi. Fungi, have various applications in the food, pharmaceutical and agricultural industries. For example, oyster and shiitake mushrooms have high economic value as consumer products, while the enzymes and bioactive compounds produced by fungi are used in various industrial processes. Unfortunately, this potential has not been fully exploited in biology learning in schools (Zurweni & Yusnaidar, 2024; Sari, 2024; Meidila & Kharnolis, 2024; Chairul, 2024).

Currently, biology learning in many schools is still theoretical and does not link biological concepts with practical applications and entrepreneurial opportunities. The Student Activity Sheets (LKPD) used often only function as tools to help understand basic concepts without developing entrepreneurial and innovation skills. In fact, the integration of the bioentrepreneurship concept in LKPD can provide a more comprehensive and relevant learning experience to the

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real world (Purnama, Arsih, Fadilah & Fajrina, 2024; Prasetyo & Kuntjoro, 2023; Aminah, Ramdhan, & Suhendar, 2023; Amalia & Isnawati, 2023; Damayanti & Ratnasari, 2021).

Although various studies have shown that project-based learning and contextual approaches can increase students' understanding and interest in science, there is still little research that specifically develops and implements bioentrepreneurship-based worksheet on fungi material. This gap shows the need for innovation in developing teaching materials that can integrate entrepreneurial concepts with biological material, so that learning becomes more relevant and applicable (Ummu & Usman, 2023; Rahman, Hidayat & Hakim, 2020). Current issues in education emphasize the importance of developing 21st century skills in students. In addition, advances in digital technology also encourage the need for interactive and technology-based learning to increase student engagement and motivation to learn. In this context, the development of bioentrepreneurship-based LKPD that utilizes digital technology can be an innovative solution to improve the quality of biology learning, including the use of technology in Augmented Reality-based learning (Geisinger, 2016; Koenig, 2011; Kennedy & Sundberg, 2020). The implementation of Augmented Reality has great potential to change the way we interact with the world around us. As technology continues to advance, we can expect to see more and more innovative applications utilizing AR (Dewi, Asfar, Damayanti, Wahyuni & Ekawati, 2023).

There are several elements that differentiate it from other research, namely: 1) integration of bioentrepreneurship: the LKPD developed integrates the concept of bioentrepreneurship with mushroom material, which has not been explored much in previous research. This provides a new dimension in biology learning that focuses not only on cognitive aspects but also on developing entrepreneurial skills; 2) use of digital technology: This worksheet is designed to utilize digital technology, which can increase student engagement and make learning more interactive. The use of applications and digital platforms in LKPD will help students access information more widely and carry out virtual experiments relevant to the topic of fungi; and 3) developing creativity and innovation: This LKPD is designed to encourage students' creativity and innovation by providing assignments that challenge them to find creative and innovative solutions related to the application of mushrooms in industry. This not only increases understanding of the material but also equips students with relevant skills for the world of work (Diniaty, & Atun, 2015; Sa'adah, Sudarmin & Diliarosta, 2021).

2. Method

The research method used is Research and Development (R&D), while the development model used is the 4D development model which is limited to the 3D stage, namely define, design and develop. The subjects used as research for small group trials were 15 class X students. Science and three validators, namely material expert validators, media experts and subject teachers to assess the feasibility of bioentrepreneurship-based LKPD. The research was carried out at one of the high schools in Ternate City and the Biology Education Study Program, FKIP Unkhair 2024. Data collection techniques were carried out through interviews and questionnaires. The instruments used were interview sheets, expert validation questionnaires, and readability questionnaires. Interview sheet. The results of interviews during the preliminary study with biology subject teachers and five students produced descriptive data regarding the use of LKPD in biology learning Expert Validation Questionnaire Sheet. After obtaining the score from filling in the validation questionnaire sheet, it is interpreted using the validation test assessment criteria contained in Table 1.

Table 1. Validation Test Assessment Criteria

Intervals	Criteria
81 – 100%	Very worthy
61 – 80%	Worthy
41 – 60%	Decent Enough
21 – 40%	Not feasible
0 – 20%	Not really worth it

LKPD readability test questionnaire sheet. The LKPD readability test questionnaire sheet contains several statements regarding students' responses to the LKPD that have been developed by researchers. The assessment scale in the student response questionnaire uses a 1-4 Likert scale. There were 15 responses that provided readability assessments. To determine the criteria, the LKPD readability test results are presented in Table 2.

Table 2. Criteria for Determining Readability Tests

Intervals	Criteria
3.3 – 4.0	Very good
2.6 – 3.2	Good
1.8 – 2.5	Fair
1.0 – 1.7	Poor

3. Results and Discussion

3.1 Results of the Development Stage of Student Activity Sheets (LKPD) Based on AR-Assisted Bioentrepreneurship on Fungi Material

The stage of developing a student activity sheet (LKPD) based on bioentrepreneurship uses a 3D development model, namely define, design, develop. The data obtained at the define stage will become the basis for developing teaching materials. The data obtained regarding the problems experienced by teachers and students is that the creation of LKPD has not been carried out optimally, the use of LKPD in learning is not used in every chapter in biology material, the results of practicums carried out by students have not been turned into business opportunities that can develop creativity and interest. student entrepreneurship, and the display of the LKPD used is less attractive in terms of color because it only uses black and white so that the image display is not clearly visible, therefore it is necessary to develop and integrate contextual learning with entrepreneurship content, one of which is by developing materials teaching in the form of LKPD based on bioentrepreneurship.

The problems obtained at the define stage will become the basis for developing a learning media designed at the design stage. The resulting media design includes several parts, namely cover, KI, KD, indicators, learning objectives, activity title, stimulus, problem identification, data collection, data processing, verification, discussion and conclusions.

The development stage aims to produce revised learning tools in the form of comments, suggestions, assessments from experts and from trial result data that has been given to students. This stage begins with validating the bioentrepreneurship-based LKPD by three experts, namely material experts, media experts and biology subject teachers. The bioentrepreneurship-based LKPD underwent one revision, there were several inputs from material expert validators resulting in a better bioentrepreneurship-based LKPD draft. After obtaining a valid product, a product readability test is carried out which aims to find out and see whether the LKPD being developed is good and suitable for use by students in the learning process. The input and suggestions from validators will be presented in Table 3 below.

Table 3. Validator's criticism and suggestions for Bioentrepreneurship-based LKPD on Fungi material

Validator	Input	Follow-up
Validator 1	<ul style="list-style-type: none"> ▪ Writing mushrooms or fungi must be consistent ▪ Write commands for each activity 	<ul style="list-style-type: none"> ▪ The writing of mushrooms or fungi is consistent ▪ Instructions for each activity have been written clearly
Validator 2	Comments: LKPD is suitable for use	There is no need to revise the Bioentrepreneurship-based LKPD on fungi material
Validator 3	The LKPD is good and can help students and teachers understand the application of fungal material	There is no need to revise the Bioentrepreneurship-based LKPD on fungi material

3.2 Validation Results of the Development of Student Activity Sheets Based on AR-Assisted Bioentrepreneurship on Fungi Material

Validation of LKPD is determined based on three aspects, namely material/content aspects, presentation aspects, and linguistic aspects. The results of the LKPD validation by four validators in each of these aspects are shown in Figure 1.

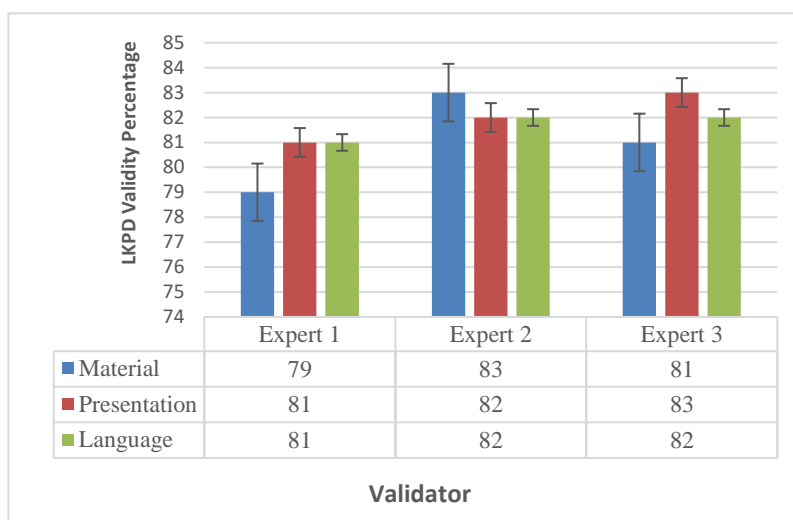


Fig. 1. The results of the LKPD validation

Based on the LKPD validation data shown in Figure 4.1, in the material/content aspect, the average percentage of LKPD validation is 81%, meaning that the LKPD developed has a very valid category. In the presentation aspect, the average percentage of LKPD validation is 82%, so the LKPD category developed in the presentation aspect is very valid. In the last aspect, namely language, the validation results from the three validators show an average percentage of 81.6%. This means that the LKPD developed has a very valid category in the linguistic aspect. Overall, the three aspects of the bioentrepreneurship-based LKPD assessment that were developed have a very valid category with an overall average percentage for the three aspects, namely 81.5%. According to Sukmadinata (2012), expert validation produces macro product suitability values so that small-scale tests are needed that can provide micro assessments. Therefore, the feasibility of LKPD must combine the results of validation from experts and students.

3.3 Results of Student Readability Tests on AR-Assisted Bioentrepreneurship-Based Student Activity Sheets (LKPD) on Fungi Material

The LKPD readability test is carried out to obtain the feasibility value of the product being developed and it is also hoped that there will be good input in the form of comments, suggestions and criticism for improving the product.

Table 4. Results of Bioentrepreneurship-Based LKPD Readability Test Questionnaire Analysis on Fungi Material

Number	Statement	Average Readability Score	Information
1	The LKPD cover presented describes the content of the material and is in accordance with the principles of bioentrepreneurship, so it attracted my interest in entrepreneurship	3.2	Good
2	The color composition of this LKPD matches the contrast with the background color, so it makes me interested in reading it	3.4	Very good
3	I feel this LKPD is easy to understand	3.7	Very good
4	The contents of this LKPD provide useful information about fungi and bioentrepreneurship	3.7	Very good
5	This LKPD helped me understand the basic concepts about fungi	3.7	Very good
6	I feel this LKPD is relevant to everyday life	3.4	Very good
7	I can easily apply the concepts taught in this LKPD	3.3	Very good
8	I feel confident that I can use the knowledge from this LKPD in the future	3.2	Very good
9	I feel this LKPD provides a clear picture of the relationship between fungi and bioentrepreneurship	3.3	Very good
10	This LKPD made me understand more about the importance of fungal conservation in bioentrepreneurship.	3.3	Very good

Number	Statement	Average Readability Score	Information
11	I feel that this LKPD pays enough attention to my learning needs.	3.5	Very good
12	I feel that this LKPD enriches my knowledge about fungi.	3.3	Very good
13	I feel this LKPD helps me develop my skills in managing information about fungi.	3.7	Very good
14	I feel that this LKPD provides a new perspective on the role of fungi in bioentrepreneurship.	3.2	Good
15	This LKPD makes me want to learn more about fungi and bioentrepreneurship.	3.2	Good
16	I feel comfortable with the writing style and language used in this LKPD.	3.3	Very good
17	I feel this LKPD motivates me to study harder.	3.2	Good
18	I feel that this LKPD helps me increase my understanding of the relationship between the environment and bioentrepreneurship.	3.0	Good
19	I feel that this LKPD provides relevant examples and helps in understanding the concepts being taught.	3.0	Good
20	I feel that this LKPD combines theory with practical application well.	3.0	Good
21	I feel this LKPD is quite challenging for me.	3.2	Good
22	I feel that this LKPD provides a complete picture of various aspects of bioentrepreneurship in the context of fungi.	3.0	Good
23	I feel that this LKPD provides an opportunity for me to think critically.	3.0	Good
24	I feel this LKPD helps me develop my skills in analyzing information about fungi.	3.0	Good
25	This LKPD made me more aware of the economic potential associated with fungal management.	3.2	Good
26	I feel that this LKPD helps me identify challenges and opportunities in the sustainable use of fungi.	3.3	Good
27	I feel this LKPD can be used as a good reference to learn more about fungi and bioentrepreneurship.	3.5	Good
28	I feel that this LKPD provides a meaningful learning experience for me.	3.3	Good

Based on the results of the analysis of the LKPD readability test questionnaire, a total of 15 people obtained an average readability test score of 3.3 in the very good category. So no improvements were made to the bioentrepreneurship-based LKPD that was being developed. This is because, according to Prasetyo & Kuntjoro, (2023) if the readability test results obtain a value in the range of 3.3-4.0 which is categorized as very good, then the product can be used without any revisions.

Conclusions about the feasibility of a product being developed can be made by combining expert validation data and LKPD readability tests (Sukmadinata, 2012). So the conclusion that can be drawn based on this data is that the bioentrepreneurship-based LKPD is valid and good so it is suitable for use at the dissemination stage. The disseminate stage was not carried out in this research because the development method was limited to the 3-D stage.

4. Conclusion

Based on the results of research on the development of Bioentrepreneurship-based Student Activity Sheets (LKPD) on fungal material, the following conclusions can be obtained:

- a. Development of a Bioentrepreneurship-based Student Activity Sheet (LKPD) on fungal material is carried out by referring to a 3-D model which consists of 3 stages, namely Define (needs analysis), Design (designing), and Develop (development).
- b. Feasibility of the Bioentrepreneurship-based Student Activity Sheet (LKPD) on fungi material, the fungus material obtained an overall validation test result of 81.5% in the very feasible category, and the overall readability test result of the LKPD by students was 3.3 in the very category. Good.

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