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Development of Organic Waste Processing Module of *Eco-Enzyme* Project-Based Learning Materials for Students

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Abstract

This study aims to develop a project-based teaching module on the production of eco-enzyme within the topic of organic waste processing for students of the Biology Education Study Program, FKIP Universitas Cordova, in the Environmental Science Fundamentals course. This research is a development study using the 4D model, consisting of the stages of define, design, develop, and disseminate. However, in this study, the process was limited only to the development stage. The results showed that the module was declared valid and feasible to use based on validation results from two expert validators (a material expert and a media expert), with a validity percentage of 77,5%, as well as a module readability test by students of 85%, indicating that the module is easy to understand. The validation results indicate that the project-based eco-enzyme production teaching module is appropriate and can be implemented in the learning process.

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1. INTRODUCTION

Education is a crucial aspect of life and involves human resources, the foundation for the nation and state. The demands of 21st-century learning regarding the quality of competent human resources are fundamental to improving the quality of education in Indonesia. The new paradigm of learning allows educators the freedom to design learning and assessments tailored to the characteristics and needs of students, as well as 21st-century skills, including communication, collaboration, critical thinking, problem-solving, creativity, and innovation (Naibaho, 2023). Learning activities should strive to achieve optimal learning objectives. Education must be able to produce individuals with high levels of knowledge, competitiveness, creativity, and good character, thereby improving the quality of human resources. Lecturers and educators must be able to create a conducive environment for students by implementing appropriate learning media and models. Students will be encouraged to think critically and understand biological concepts, particularly environmental biology, so they can solve everyday problems, including solutions to environmental problems, and make breakthrough innovations in processing organic, inorganic, and plastic waste.

The fundamentals of environmental science course is a compulsory subject for first-semester students in the Biology Education Study Program at Cordova University. Currently, the course utilizes several reference sources from the internet and other sources. To achieve optimal learning objectives, additional practical teaching materials are required. The lecturer in charge of the course has never developed specific teaching materials for waste management, resulting in a lack of student independence in learning. The hope is that through efforts to develop teaching

materials, students will be able to learn competencies coherently and systematically, thereby maximizing the learning process and outcomes. The goal is to support improved learning quality, which can train students' abilities in several aspects, especially skills. Learning activities in waste management require the use of appropriate and practical learning media. Learning media is a crucial part of improving learning outcomes (Rahman et al. 2022). One interesting learning medium is the use of modules.

A module is a teaching material that is packaged completely and systematically, containing a set of planned learning experiences designed to help students master specific learning objectives (Gunawan, R. 2022). The module contains learning objectives, learning materials or substances, and evaluation. This project-based ecoenzyme production practice was developed according to students' needs to achieve maximum learning objectives as expected. The appropriate learning model integrated with teaching materials in the form of modules consists of several stages as a form of practical learning experience for students, namely starting from making project plans, implementation, making project results reports, and presenting the resulting products. In accordance with the demands of 21st-century education by utilizing and integrating knowledge and technology in the learning process, it is very important to provide students need to be given learning experiences that can train critical thinking skills and skills through the use of practical teaching materials in the form of ecoenzyme production modules.

Learning experiences through innovative activities about the environment will certainly have a positive impact on ecological awareness because it is supported by real, practical activities. Waste is the remainder of human daily activities resulting from a production process, both industrial and domestic (household), in the form of solid substances, namely organic and inorganic waste, that is considered no longer useful in everyday life. The types of waste around are quite diverse, including household waste, market waste, livestock waste, industrial waste, residential waste, and waste in offices and schools (Asteria, 2025). Large volumes of waste can potentially release methane gas, which can increase greenhouse gas emissions, automatically contributing to global warming. The new paradigm is that waste can be processed and utilized into products that have economic value and can be reused in accordance with the 3R principle (low, Reuse, and Recycle). The solution to the organic waste problem is through eco fermentation by Junaidi, R (2021) is an effective and efficient solution in handling and processing accumulated organic waste, or waste that is often burned, which can cause pollution effects. Ecoenzyme is a liquid formed from the fermentation of organic waste such as fruit peels, vegetables, water, and brown sugar, so that this liquid is dark brown and has a strong sour and sweet aroma (Galintin et al, 2021). The advantages of making ecoenzymes are that the tools and materials are easy to obtain, do not require a large space, and the purpose of utilizing ecoenzymes can reduce the amount of household waste, especially organic waste, the composition of which is still very high (Prasetio, Ristiawati, and Philiyanti, 2021). Based on the explanation above, the researchers conducted development research with a product in the form of a project-based ecoenzyme production teaching module with the hope of helping students integrate academic knowledge with real practical experience in sustainable environmental management, especially in West Sumbawa Regency (KSB).

2. METHOD

The research conducted includes 4D development research consisting of four stages, namely Define (Definition), *Design* (Planning), *Develop* (Development), and distribute. However, this research is limited to the development stage only (3D). The stages of development research that have been carried out are as follows:

1. *Step of Define* (Definition)
   Researchers conducted curriculum analysis, material analysis, and student characteristics analysis because the development of teaching materials must be in accordance with student needs. Formulating learning objectives related to the manufacture of ecoenzymes using organic waste from household waste in Taliwang District, West Sumbawa Regency.

2. Step of *Design* (Planning)
   At this stage, the researcher plans to develop a product that can be used by lecturers and students in lectures on the fundamentals of environmental science, particularly waste management. The design focuses on determining the module cover design, module content, validation by a team of experts, and design revisions. The cover design for the project-based ecoenzyme production module is as follows.

Figure 1. Module Cover Design

3. *Step of Develop* (Development)
   This stage is the production stage, and the resulting development results in the form of a designed module. It will then be validated by expert validators to assess the product's feasibility based on several existing assessment indicators, ensuring its suitability and readiness for use in the learning process. The module development research stages are shown in the following diagram.

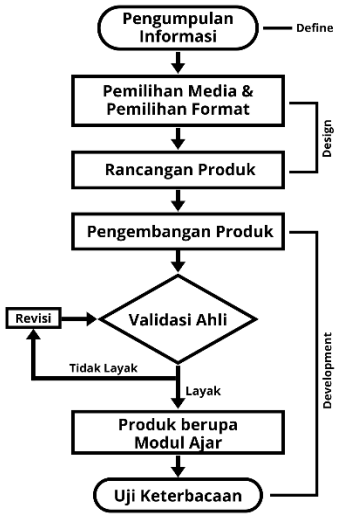


Figure 2. 3D Stage Diagram

The results from the expert validator were then analyzed using the average score analysis technique based on the validity criteria according to the average score of Vendiktama et al. (2018 as follows.

The table of validity criteria for the ecoenzyme module as student teaching material is as follows.

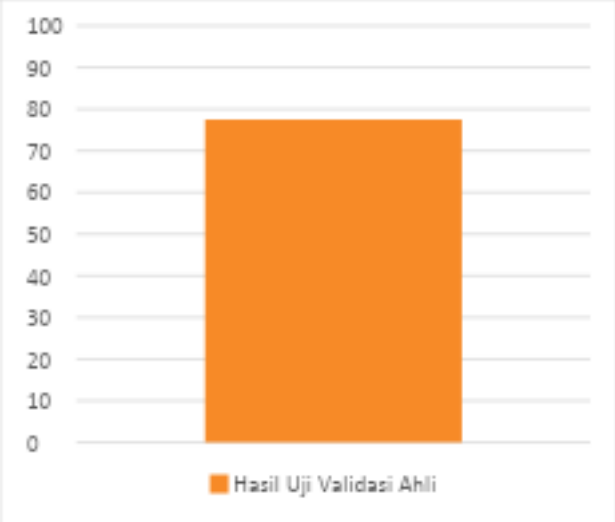
Achievement Level	Criteria	Information
>80	Very good	No revision needed
70-79	Good	No revision needed
60-69	Enough	Revision
50-59	not enough	Revision
<50	Very less	Revision

3. RESULTS AND DISCUSSION

The development research that has been carried out produces a product in the form of a learning module for students of the biology education study program, FKIP, Cordova University, with practical activities in making ecoenzymes using organic waste sourced from household waste in the Taliwang sub-district. The findings of this development research are in the form of a project-based eco enzyme-making teaching module product that is feasible and ready to be applied in the lecture process by the lecturer and students. The feasibility criteria are obtained after an assessment by a team of experts, or both validators of the module content, and the results show valid criteria after going through a revision stage based on the input suggestions of expert validators. Meanwhile, the module readability test by students is relatively easy because the module content is easy to understand according to the established criteria. The development research of the ecoenzyme-making teaching module in the basics of environmental science course has enormous benefits in learning because it can help lecturers and students achieve maximum learning objectives, as it is supported by the use of creative and innovative media and learning models. The benefits for students are training students to carry out direct practice through project-based learning, specifically for ecoenzyme-making activities, in order to provide economically and ecologically applicable skills.

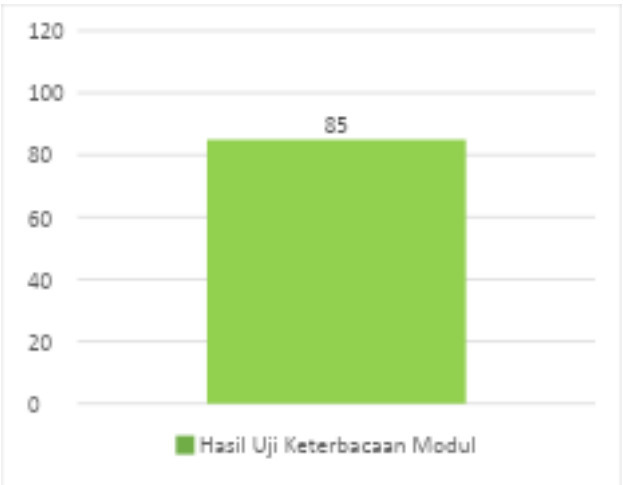
This research provides significant benefits for lecturers covering academic and professional aspects, as well as contributions to environmental sustainability in accordance with the courses they teach. Lecturers gain experience developing teaching materials that are appropriate to students' needs and for educational advancement. The selection of the right model in the learning process is an important element because the activities contained in the developed module can train and develop students' abilities and skills through real-world practical learning experiences, as an innovation by applying theory to produce products in the form of ecoenzymes by utilizing organic waste in the surrounding environment. The benefits can help reduce waste generation in the environment by carrying out processing innovations as a form of concern for a sustainable environment. This development research is supported by a review of several previous research results that are relevant to the research to strengthen the results and findings of research innovations that have been carried out.

The results of the development research conducted were in the form of module validation results by two expert validators and the results of the module readability test by first-semester students of the biology education study program, FKIP, Cordova University. The suggestions and input from both validators included improving the cover to make it more attractive, making the instructions for the stages of implementing the ecoenzyme production practice clearer and more detailed, including links or websites for easy student access. Then, the revision process continued with a validation result of 77.5% as can be seen in the following graph.



Graph 1. Expert validation test results

The results of the module readability test by students through filling out a questionnaire were 85%, meaning the module developed was in the category of easy to understand by students. Aspects observed and assessed included cover attractiveness, clarity of learning objectives, language suitability, terminology accuracy, layout, sentence clarity, material coherence, language style, stages of practical activities, practice questions and evaluations, feedback, clarity of instructions in the module, and summary. The results of the module readability test can be seen in the following graph.



Graph 2. Module readability test results

Previous research that is relevant to this research is the development of an E-module for processing organic waste using ecoenzymes on the material *green chemistry* for high school students of class X with the results in the form of E-module products and validation results by media expert validators 96.77% in the very valid category, while the material expert validator 98.63% in the very valid category so that the E-module that has been developed and validated is feasible and ready to be applied in learning. The conclusion of the research results is that the use of teaching materials in the form of modules is very helpful for students in improving cognitive, affective, and psychomotor abilities. In addition, the use of appropriate teaching materials can improve the learning process and outcomes of students.

4. CONCLUSION

The development research conducted concludes that the developed module is considered feasible and ready to be implemented in the learning process by lecturers and students of the

biology education study program, FKIP, Cordova University, according to the validation results carried out by the two validators. The developed module is considered easy to understand based on the results of the module readability test by 13 first-semester biology education students, FKIP, Cordova University.

5. SUGGESTION

This research suggests that lecturers introduce this module through scientific forums, such as workshops and seminars for lecturers and teachers. Furthermore, further research is needed to implement the developed product to determine its effectiveness in learning.

6. ACKNOWLEDGEMENT

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7. BIBLIOGRAPHY

Asteria, D., dan Herman, H. (2015). Bank Sampah sebagai Alternatif Strategi Pengelolaan Sampah Berbasis Mahasiswa di Tasikmalaya. Jurnal Manusia dan Lingkungan, Vol. 23, No.1. Universitas Indonesia.

Galintin, O., Rasit,N., dan Hamzah, S. (2021). Production and characterization of Eco Enzyme Produced from Fruit & Vegetable Wastes and Its Influence and the Aquaculture Sludge. Biointerface Research in Applied Chemistry, 11 (3), 10205-10214.

Gunawan, R. (2022). *Modul Pelatihan* Pengembangan *Bahan Ajar/Modul Pembelajaran*. Bandung: CV Fenils Muda Sejahtera.

Junaidi, R. J., Zaini, M., R.,Hasan, M.,Ranti, B.Y.Z., B., M.W., Umayasari, S., Sulistyo, A., Aprilia, R. D., & Hardiansyah, F. (2021). Pembuatan Ekoenzim sebagai Solusi Pengolahan Limbah Rumah Tangga. Jurnal Pembelajaran Pemberdayaan Masyarakat (JP2M), 2 (2), 118-123. https://doi.org/10.33474/jp2m.v2i2.107602021.

Naibaho, D.P. (2023). Strategi Pembelajaran Berdiferensiasi mampu Meningkatkan Pemahaman Belajar Peserta Didik. Journal of Creative Student Research, 1 (2), 81-91.

Nova Lestari Siagian, (2024). Desain dan Uji coba E-Modul Pengolahan Limbah Organik dengan Cara Pembuatan Eco-Enzyme pada Materi Green Chemistry Sekolah Menengah Atas kelas X. Skripsi thesis, Universitas Islam Negeri Sultan Syarif Kasim Riau.

Rahman, M.Y.A., Syaripudin, T., & Riyadi, A.R (2022). Permainan Petualangan di luclece berbasis Android untuk Meningkatkan Hasil Belajar IPA kelas VI SD. Jurnal Pendidikan Guru SD, 7 (1), 35-40.

Vendiktama, P. R., Al Muhdhar, M.H.I. dan Suarsini, E. (2018). Pengembangan Modul Biologi Bermuatan Konsep 6M dan Etika Lingkungan Berbasis Project Based Learning (PjBL) untuk Siswa SMA. Jurnal Pendidikan. Volume 3 (2) Februari 2018.

V. M. Prasetio.T. Ristiawati, and F.Philiyanti. "Manfaat Eco-Enzme pada Lingkungan Hidup serta Workshop Pembuatan Eco-Enzyme," Darmacitya J.Pengabdi. Kpd. Masy., vol. 1, no. 1, pp. 21-29, 2021, [online]. Available: http://journal.unj.ac.id/unj/index.php/darmacitya/article/view/24071