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Needs Analysis of Education for Sustainable Development-Oriented Textbooks in Biotechnology Courses

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Abstract

Sustainability competencies can be developed through Education for Sustainable Development (ESD) whose implementation will be assisted by appropriate teaching materials. The purpose of this study was to determine students' perceptions and initial knowledge, conditions, and difficulties experienced, as well as the form of teaching materials that can facilitate students to achieve competence in biotechnology courses. This descriptive quantitative research was conducted on 30 students who had taken biotechnology courses at the Department of Biology, Universitas Negeri Malang, who were selected by purposive sampling. Data collection using survey techniques and review of Semester Learning Plan (RPS) documents. The survey results were analyzed descriptively using percentages. The results showed that 64% of students placed biotechnology in the field of biorefinery as material that was not understood in biotechnology courses, only 13% of students used knowledge and skills from biotechnology lectures to support resilience (sustainability) in the community around their place of residence, and 83% of students thought that textbooks were teaching materials that were considered easy to understand biotechnology material. However, the main problem felt by 63% of students during the biotechnology course was the difficulty in accessing appropriate teaching materials (20% felt very difficult and 43% felt difficult). So, it can be concluded that ESD-oriented textbooks with material content on the application of fermentation technology in biorefinery need to be developed.

Keywords : biotechnology courses, ESD, needs analysis, textbook

INTRODUCTION

Higher education plays an important and strategic role in improving the quality of educated human resources as the main asset in the developing countries (Craps et al., 2022; Díaz-Méndez et al., 2019; Falqueto et al., 2020; Fox et al., 2020; Leal Filho et al., 2019; Moreno et al., 2019). Major development challenges in the 21st century is directed toward sustainability (Furstenau et al., 2020; Müller et al., 2018; Pauw et al., 2015; Ramos-Mejía et al., 2018; Verma & Raghubanshi, 2018). Development toward sustainability can run well if human resources have the required sustainability competencies including systems-thinking competence, anticipatory competence, normative competence, strategic competence, and interpersonal competence (Brundiers et al., 2021; Pálsdóttir & Jóhannsdóttir, 2021).

Sustainable competencies are very important for students because they not only integrate knowledge, skills, attitudes and values (Grohs et al., 2018), but also can bring the vision of local wisdom to society (Ryan & Tilbury, 2010). By having sustainable competencies, students have a sustainable mindset and in action can help support resilience in society (Ferrer-Balas et al., 2010). Therefore, the development of sustainable competencies in students is needed to form sustainability change agents in society.

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Sustainability competencies can be acquired and developed through Education for Sustainable Development (Cebrián et al., 2020). The implementation of ESD that is widely used in the Asia-Pacific region is through formal education (Leal Filho et al., 2022). One approach that can be used to integrate ESD at the university level is through a vertical approach by integrating ESD into courses (Fernandez-Sanchez et al., 2014; Imara & Altinay, 2021), for example, biotechnology courses at the Universitas Negeri Malang.

Biotechnology is a field of application of bioscience and technology that concerns the practical application of living organisms or their subcellular components in service and manufacturing industries and environmental management (Lokko et al., 2018; Shabbir et al., 2021). This relates to several themes that can be taught in ESD including energy conservation and alternative energy exploration, green technology, transportation and emissions, oceans, biodiversity, and sustainable production and consumption (Filho et al., 2009).

The implementation of ESD in courses will be helped by the existence of appropriate teaching materials (Lee, 2023). Teaching materials can help educators in conducting learning and teaching activities and help learners to meet the standards of competency achievement or learning achievements that have been determined (Milligan et al., 2019). Based on some of these things, the purpose of this analysis is to find out 1) the perceptions and initial knowledge of students, 2) the conditions and difficulties experienced by students, and 3) the form of teaching media or materials that can facilitate students in achieving competence in biotechnology courses.

METHOD

This descriptive quantitative research was conducted through a survey. The research respondents were 30 students who had taken biotechnology courses at the Department of Biology, Universitas Negeri Malang. Data collection was carried out using electronic survey techniques by utilizing Google form facilities and reviewing the semester lecture plan document made by the lecturer teaching the biotechnology course. The questionnaire used has been reviewed by measurement instrument experts with final validity score of 100% after going through 2 revision processes. The needs analysis questionnaire lattice used can be seen in Table 1. The questionnaire results were analyzed descriptively using percentages.

Table 1. Needs Analysis Questionnaire Grid

Aspect	Indicators	Item	Total
Perception and Initial Knowledge of Students	1) Students' Perception of biotechnology courses	1	1
	2) Students' understanding of the material in the biotechnology course	2, 3, 4, 5, 6, and 7	6
	3) Utilization of competencies gained from the biotechnology course	32 and 33	2
Conditions and Difficulties Experienced by Students	1) Gender	On student identity	1
	2) Ways of Learning & Teaching in biotechnology courses	8, 9, 10, 11, and 12	5
	3) Characteristics of learners	29, 30, and 31	3
	4) Learning difficulties experienced by students	24, 25, 26, 27, and 28	5
Needs of the Type of Teaching Material	1) Use of teaching materials, technology, and learning media	13, 14, 15, 16, 17, 18, 19, 20, 21, 22 and 23	11

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RESULTS AND DISCUSSION

Perception and Initial Knowledge of Students

Based on the survey results, it is known that most students have the perception that biotechnology courses are very important as shown in Figure 1.

Figure 1. Percentage of Students' Perceptions of Biotechnology Courses

In addition, based on the survey results, the majority of students ranked biotechnology in the field of biorefinery as the most difficult material to understand in biotechnology, as presented in Figure 2. This is because in the semester learning plan there is no specific material that discusses biorefinery in depth. So that students tend to consider biorefinery as something they do not understand well.

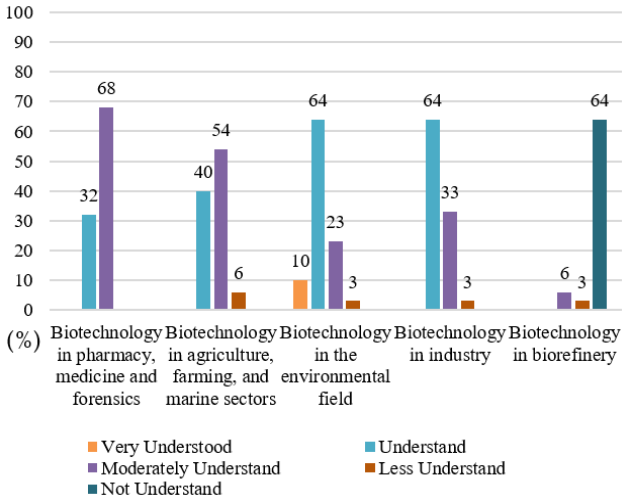

Figure 2. Percentage of Students' Level of Understanding of Various Biotechnology Materials

Biorefinery is the technology of converting plant biomass into energy molecules or chemical molecules (Cherubini, 2010), which is one of the applications of biotechnology. Biorefinery as part of biotechnology utilizes fermentation mechanisms and technology. This is following one of the learning sub-achievements of biotechnology courses, namely being able to describe fermentation technology. Based on a review of the biotechnology semester lecture plan document, the topic on fermentation mechanisms and technology has only been focused on food products (such as yogurt, tempeh, and nata). So, fermentation techniques in the biorefinery field can be used as a variety of material content in the sub-topic on fermentation mechanisms and techniques.

Most students use the knowledge and skills gained from biotechnology lectures to enrich their own knowledge and skills. Only a few of them use it to support sustainability in the communities where they live. How students use and apply the knowledge and skills acquired during biotechnology lectures can be seen in Figure 3.

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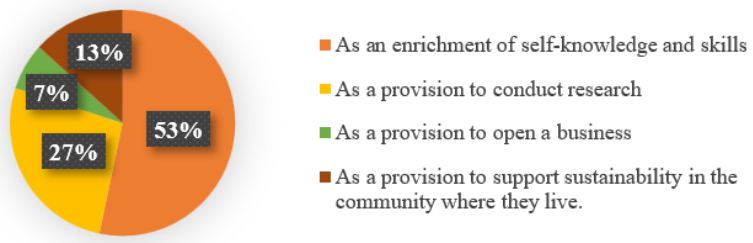

Figure 3. Percentage of How Students Use and Apply the Knowledge and Skills Acquired during Biotechnology Lectures

Conditions and Difficulties Experienced by Students

The survey results show that most of the students were female, as shown in Figure 4. Gender is one of the factors in learning. Differences in learning styles between men and women have been highlighted in various studies. In addition, gender differences extend to communication styles, emphasizing the different social preferences observed during the learning process (Tatarinceva, 2009). In other studies, gender can have an impact on student' performance (Awan & Azeem, 2017) and student' learning outcomes (Akinyemi et al., 2020).

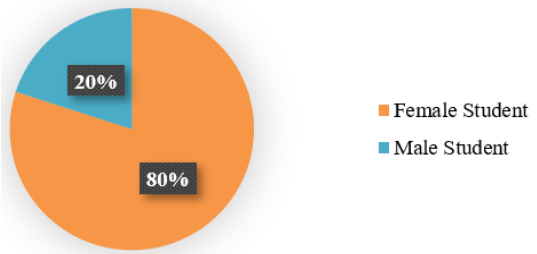

Figure 4. Percentage of Students' Gender

Most students find it easier to understand things in a visio-motor way, as shown in Figure 5.

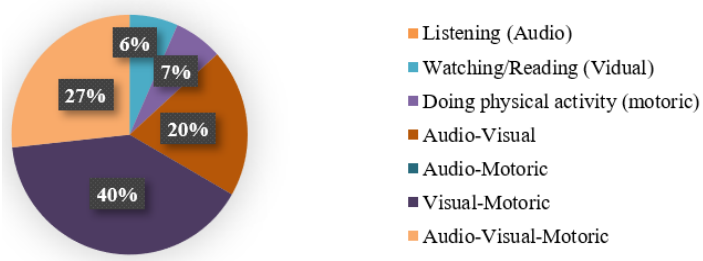

Figure 5. Percentage of Students' Way of Understanding Something

Learning and teaching methods in biotechnology courses that are considered the most helpful in adding competence by most students are project and problem-solving methods, as presented in Figure 6. Meanwhile, the results of the review of the biotechnology semester lecture plan document show that biotechnology courses are only carried out by classical discussion and presentation methods.

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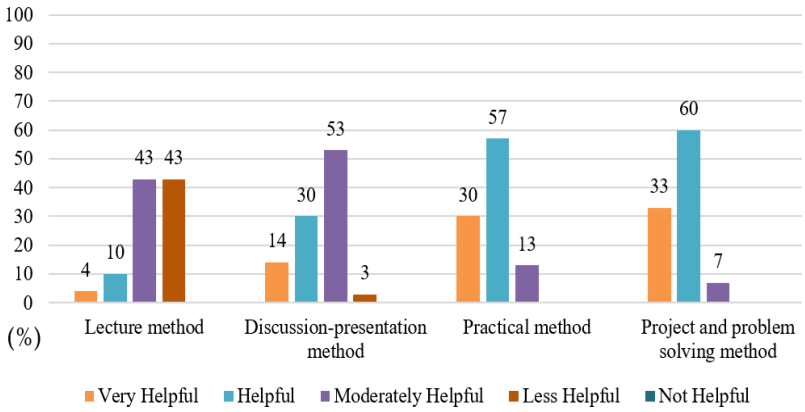

Figure 6. Percentage of the Level of Usefulness of Learning and Teaching Methods in Biotechnology Courses to Increase Student Competence

The most preferred form of assignment by most students is in the form of a project, as presented in Figure 7.

Figure 7. Percentage of Students' Preferred form of Assignment

Project and problem-solving methods are considered to make it easier for students to understand topics and achieve competencies. Unfortunately, based on a review of the biotechnology semester lecture plan document, that is not in line with the methods used in biotechnology courses, especially on the topic of fermentation mechanisms and technology, which still use classical discussions and presentations only.

Most students revealed that the benefits of technology for them are as a medium to find learning resources, as shown in Figure 8.

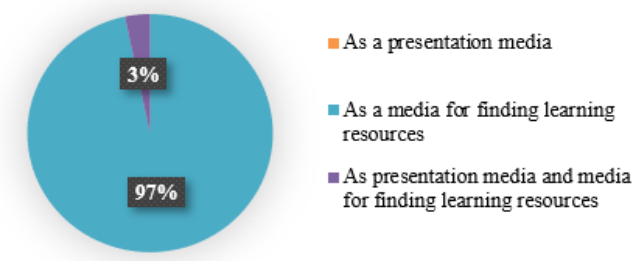

Figure 8. Percentage of Technology Benefits for Students in Biotechnology Courses

The main difficulty felt by the majority of students when undergoing biotechnology courses is in accessing appropriate teaching materials, as shown in Figure 9.

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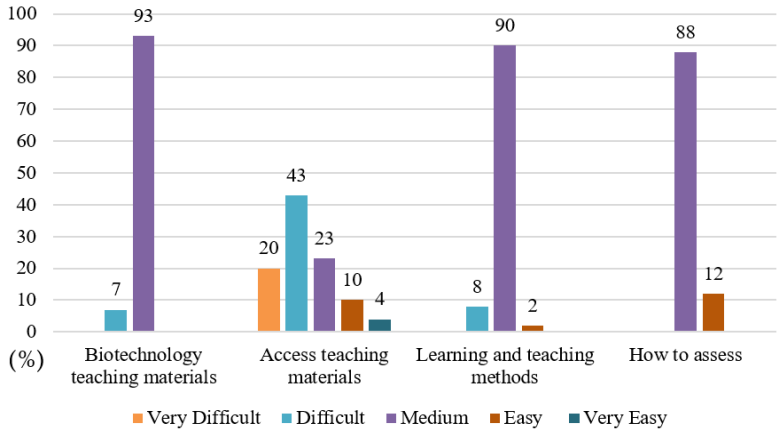

Figure 9. Percentage of Learning Difficulties Experienced by Students in Biotechnology Courses

Needs of the Type of Teaching Material

Teaching materials that make it easier to understand biotechnology material according to the majority of students are printed teaching materials in the form of textbooks, as shown in Figure 10.

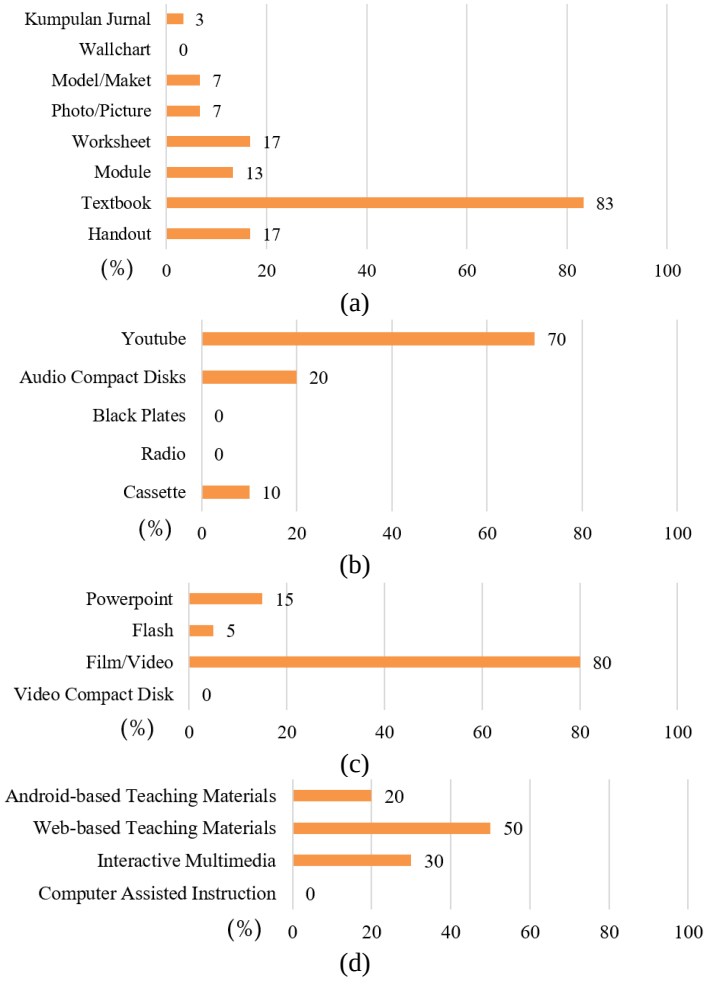

Figure 10. Percentage of the Level of Use of Various Forms of Teaching Materials (a) Printed, (b) Audio, (c) Audio-Visual, and (d) Interactive Multimedia in Biotechnology Courses

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The teaching materials most widely used by students in biotechnology courses are printed teaching materials in the form of textbooks, but the main difficulty in biotechnology courses felt by students is precisely in terms of accessing appropriate teaching materials. Teaching materials can be made and arranged systematically in various forms according to the needs and characteristics of the material to be presented (Bahtiar, 2015; Basaroh et al., 2021; Mardiyanti, 2024). Textbooks are one form of printed teaching material that plays an important and strategic role in improving the quality of education and is the main teaching material in higher education (Costello & Bolger, 2019; van Campenhout et al., 2021). The variety of books as teaching materials in higher education includes reference books, monographs, textbooks, dictates, modules, and book chapters (Ditjen Risbang, 2017).

Based on this, it is necessary to develop teaching materials in the form of books, in this case, a textbook was chosen that contains project activities and problem-solving about fermentation techniques in the field of biorefinery to broaden students' insights and improve the achievement of biotechnology courses. Textbooks are handbooks containing a collection of course materials equipped with assignments, exercises, evaluations, and other supporters to support the learning process and can help students to learn independently (Bahtiar, 2015; Costello & Bolger, 2019). Textbooks can be compiled from research or the author's experience and refer to the curriculum (Ditjen Risbang, 2017), in this case, the biotechnology semester lecture plan document.

Biotechnology textbooks for the Undergraduate Students of Biology Program at Universitas Negeri Malang have previously been developed from procedures and research results by Pambudiono et al. so that they are applicable and contextual to add insight and become guidelines for students to carry out similar research. The textbook is suitable for use with a validity percentage of 91.6% from material experts, 90.81% from media experts, and 85.56% from small group tests (Pambudiono et al., 2016), although it is not specifically aimed at sustainability development in Indonesia.

This can affect students' perceptions and interest in sustainability as evidenced by only 53% of students using the knowledge and skills gained from biotechnology courses as an enrichment of their knowledge and skills and only 13% of students using it as a provision to support sustainability in the community around their place of residence. Based on this, it is necessary to add elements of developing student sustainability competencies through ESD in the developed textbook. Integration of sustainability issues into the curriculum and science textbooks is very important as a first step to developing sustainability competencies (Johnston, 2017).

Teaching materials that need to be developed and used in ESD to achieve sustainability competencies are categorized into 1) content-based thematic teaching materials, 2) teaching materials that contain real examples around the learner's environment, and 3) teaching materials for practical performance to facilitate the formation of sustainability concepts. Science textbooks provide key information and can also develop the capacity of learning and thinking strategies to shape perspectives, values, and actions that lead to sustainability. Some approaches to integrating ESD into the content of science textbooks include 1) a thematic approach that links sustainability issues to the curriculum; 2) a problem-based learning approach; and 3) a science, society, and environment approach that links science materials to sustainability issues (Johnston, 2017).

The results of the analysis also show that students tend to use technology in biotechnology courses as a means to access learning resources and learning media that are considered to make it easier for students to understand teaching materials and achieve competencies, namely laboratory equipment.

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Based on this, ESD-oriented textbooks that contain fermentation technology material in the biorefinery field for biotechnology courses can be combined with the use of technology and include laboratory activities that refer to offline, online, synchronous, and asynchronous learning. Methods that provide access to online-based content or information or multimedia (such as text, video, images, and sound recordings) are classified as synchronous and asynchronous learning (Shahabadi & Uplane, 2015) so that they can support learner-centered learning, increase motivation and interest in learning (Jenni & Marja, 2012), enrich learning methods, and create meaningful activities for learners (Rikala & Kankaanranta, 2014).

CONCLUSION

The conclusions obtained from the results of this study are 1) students have the perception that biotechnology courses are very important and biotechnology in the field of the biorefinery is the material that is considered the most difficult for students to understand, 2) accessing appropriate teaching materials is the biggest difficulty for students in biotechnology courses, and 3) the teaching materials most widely used by students in biotechnology courses are printed teaching materials in the form of textbooks. Thus, it is necessary to develop ESD-oriented textbooks with material content on the application of fermentation technology in the field of biorefinery for biotechnology courses that refer to offline, online, synchronous, and asynchronous learning. This is intended to develop students' sustainability competencies as important capital in nation-building toward sustainability.

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