Review of learning materials of an ecology course at Universitas Terbuka

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Abstract

Purpose – This article presented the results of studies that examined the appropriateness of the content, readability of printed learning materials and the effectiveness of external resources in ecology course offered at Universitas Terbuka. To integrate external resources, links to their websites were provided in the printed materials.

Design/methodology/approach – An in-depth interview with a content expert was employed to review the course content, while digital and printed learning materials were reviewed for readability and to determine the usefulness of the external resources. A total of 47 students completed surveys and a focus group discussion that included in-depth interviews were conducted with 21 selected students.

Findings – The results revealed that the content of ecology course was conceptually valid. However, two key aspects needed to be emphasized, including the application of ecology phenomena for further development of the science and its applications in real-life situations. Regarding readability, students stated that the course materials were easily comprehended. In terms of the benefit, 79% of the students found the external resources interesting and helpful in understanding the learning materials.

Practical implications – Printed learning materials were crucial for students, specifically those residing in remote areas. Therefore, the institution should ensure that the materials were high-quality, easy to comprehend and enriched with up-to-date content/materials through scannable links to external resources.

Originality/value – The value added to the findings of this study was that the provision of links to external resources within printed learning materials improves students' understanding of the course content.

Keywords Open and distance education (ODE), Biology, Open educational resources, Flexible learning
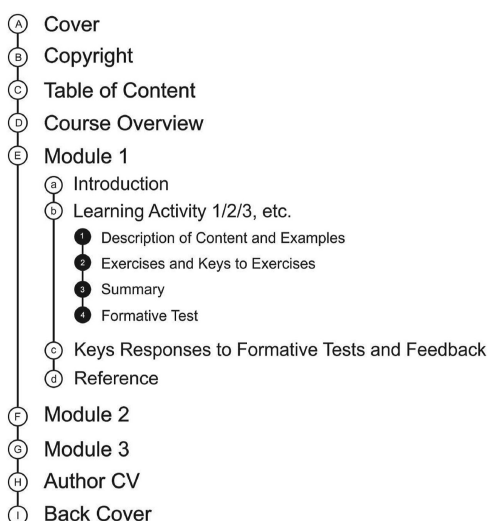
Paper type Research paper

Introduction

Learning materials for distance education students are designed as self-instructional materials that can be learned independently. Therefore, as a distance teaching university, Universitas Terbuka's learning materials are structured in such a way to be learned by students independently, as shown in Figure 1.

Ⓐ Cover
Ⓑ Copyright
Ⓒ Table of Content
Ⓓ Course Overview
Ⓔ Module 1
  ⓐ Introduction
  ⓑ Learning Activity 1/2/3, etc.
    ❶ Description of Content and Examples
    ❷ Exercises and Keys to Exercises
    ❸ Summary
    ❹ Formative Test
  ⓒ Keys Responses to Formative Tests and Feedback
  ⓓ Reference
Ⓕ Module 2
Ⓖ Module 3
Ⓗ Author CV
Ⓘ Back Cover

Source(s): Figure by authors

Figure 1.
Structure of
Universitas Terbuka
learning materials

As shown in Figure 1, each course consists of several modules in accordance with its credit units. These modules are composed of Introduction sections, Learning Activities, Key Responses to Formative Tests and Feedback and Reference materials. Within each Learning Activity, students can expect to encounter explanations of relevant concepts, theories and examples, as well as links to external resources that serve as supplementary and enrichment materials.

As an open and distance learning provider, Universitas Terbuka has faced numerous challenges in ensuring that it delivers high-quality learning materials capable of catering to the diverse needs of students. Given that students come from different geographical areas, possess varying cultural and economic backgrounds and have access to different facilities and infrastructure, providing digital learning materials alone is insufficient. Printed learning materials are essential for those who lack Internet access. Therefore, it is essential to ensure that the content of these materials is updated regularly with their design and layout capable of facilitating students' understanding of the content. The learning materials design and layout are intended to make learning enjoyable and straightforward, enabling students to learn independently.

Ecology course is one of the interdisciplinary courses under the Biology Study Program, Faculty of Science and Technology. Upon completion of the course, students are expected to have a firm grasp of the fundamental concepts and principles of ecology and the ability to apply them in their daily lives. However, developing application competence through learning media in open and distance learning can be difficult. This challenge is compounded by the fact that ecology is a field closely tied to the environment, which undergoes rapid changes. This means it is essential to integrate strategic ecology and environmental issues into the principles and concepts of ecology competence that students must master.

Furthermore, it is important to examine the learning materials' validity from the perspective of an ecology expert and students' viewpoint to ensure the concepts and principles are in accordance with the needed competencies. This study aims to evaluate the appropriateness of the materials and the readability level of ecology courses provided to distant education students.

Previous studies on ecology course reviews

Ecology is a vital aspect of daily life and has far-reaching effects on all human existence. The significance of ecology is further underscored in the United Nations' 2030 Agenda for Sustainable Development, which outlines goals to be achieved by 2030 (United Nations, 2015). Many studies explored ecology as a field of study, particularly at higher education levels, focusing on improving the effectiveness of teaching students about the subject.

Gravoso *et al.* (2008) conducted a study investigating effective ways of teaching ecology concepts in various contexts. The study highlighted that to teach ecology effectively, learning strategies must follow educational technology principles, allowing teachers to present the subject matter in a 'systematic' sequence and methods, thereby promoting students to construct their own meaning. Another study by Lundholm (2004) demonstrated the importance of teaching ecology in context, as students contextualize ecology concepts differently in their various science, cultural, socio-political and applied contexts based on their value judgments. Damsa and Jornet (2016) underscored the importance of incorporating social-cultural context, intellectual and affective aspects, and learning environments when teaching ecology.

Several other studies on teaching ecology emphasized the importance of using interactive learning materials that actively engage students in learning (Duh and Krašna, 2011). Septiani *et al.* (2020) reported the significance of interactive multimedia courseware in enhancing students' learning process and characters. In addition, Williams *et al.* (2011) found that social networking media increase the potential range and scope for emergent learning, such as ongoing exploration of ecology in the local area.

It is important for open, distance and online learning to employ various synchronous and asynchronous delivery methods to cater to the needs of students. The study by Harris *et al.* (2020) experimented with the use of active online learning to enhance inclusive instruction in ecology and biology courses and improve students' online experience. The study found that active and inclusive online classes helped students to connect better with their learning, peers and environment, leading to higher levels of performance, retention and persistence. Richter *et al.* (2021) further called for adapting field-based ecology laboratories for online learning to provide a learning experience for students to connect to their environment, which was relevant during COVID-19 and its aftermath. The study showed that online collaboration combined with field-based experience in ecology courses provided further options for the students to adapt to experience levels, resource availability and accessibility while enhancing the learning experience through collaboration between teachers and students.

In summary, enhancing students' learning experiences is crucial to improve their comprehension of complex ecology concepts. As demonstrated in previous studies, this can be achieved by designing learning materials that facilitate a comprehensive understanding of ecology principles. This present study aims to conduct research and development on distance and online learning materials for an ecology course to enhance students' ability to grasp the concepts and apply them to real-life situations. It advocates for engaging students with external resources, including those from the natural environment, to enable them to construct their understanding of ecology concepts.

Study method

This study utilized a research and development approach based on the models proposed by Gall *et al.* (2007) and Dick *et al.* (2015). It was a three-year research and development (R&D) study that aimed at developing comprehensive interactive learning materials for ecology course offered by the Biology Study Program. The first year was dedicated to developing the instructional design of the course, while the second year focused on refining the learning

materials based on the design created in the previous year. In the third year, this study was conducted to assess the content validity of the learning materials by an expert in the subject matter, evaluate the readability of the materials and examine the extent to which students used external resources to enrich their learning experience. The overall activities of learning material development are shown in Figure 2. This article reported the findings of the third-year study.

Content validity was assessed through an in-depth interview with Purwanto, Y., Executive Director of the Indonesia Man and the Biosphere (MAB), a chapter of UNESCO, as well as a professor of ecology. The interview was based on questions related to the following issues:

(1) The accuracy of the content in terms of theory, concept, examples and enrichment materials,

(2) The comprehensiveness and suitability of the content for bachelor level of study, and

(3) The scope and depth of the content at the bachelor level.

An online survey and a focus group discussion with a group of 21 selected students were used to evaluate the readability of the learning materials. The survey was sent to all 240 students who registered for the ecology course in Semester 2021.1 along with a link to the learning material. Students were required to read both printed and digital learning materials before providing feedback. Only 47 students, 20% of the total respondents, completed and returned the questionnaire, which was analyzed using the simple frequency distribution.

The data were validated by conducting a focus group discussion with 21 students invited to answer the following questions asked in the questionnaire:
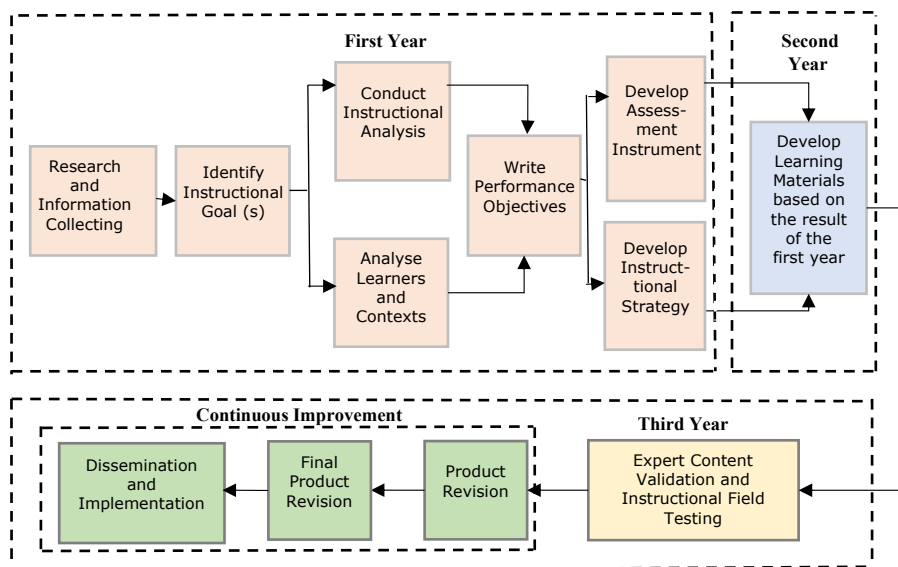
Figure 2.
Series of activities used in research and development

Source(s): Figure by authors

Questions on readability

(1) What did students prefer to learn, using printed or online learning materials?

(2) What did students think about the overall appearance of the learning materials in terms of text, font and length of the paragraph?

(3) What did students think about the suitability of the illustrations and images to the text?

Questions on external resources

(1) How easily did students access the external resources from the links provided in the learning materials?

(2) What did students think about the relevance and accuracy of the external resources to ecology concepts being taught?

(3) How easily did students understand the materials from the external resources?

(4) What did students think about the quality of the external resource?

Feedback from students was tabulated and analyzed qualitatively.

Findings
Content validation by an ecology expert
As self-contained materials, ecology concepts needed by distance students to master the learning outcomes must be contained in the learning materials. Therefore, it is essential to organize the content of the ecology materials in a comprehensive, systematic and structured way, to ensure they serve as a substitute for lectures.

The analysis conducted on ecology content reveals that, as a part of the biological sciences, it effectively describes the spectrum and concept. However, it is crucial to establish a foundation of understanding by presenting nature's complex and orderly workings and to provide a general insight into ecology phenomena before delving into more detailed concepts. It is also important to highlight the benefits and ecology functions the environment provides, specifically those relevant to humans.

Ecology is a subject closely linked to the environment, where rapid changes occur. This creates a challenge in developing constantly updated learning materials, including integrating dynamic environmental issues into ecology principles and concepts. Unfortunately, existing materials provide few examples. To ensure students understand not only concept, but also good practices for addressing ecology problems, it is important to incorporate Sustainable Development Goals (SDGs) materials into ecology education. Students should be familiarized with SDGs, which are universal, global, integrated, peaceful, inclusive and promote ethical values in ecosystem management (United Nations, 2015).

In addition, it is crucial to include teachings on how humans can manage the ecosystem through ethical norms and values that promote mutual respect for all living things. This is essential in ecology education because students need to understand the impact of human actions on the environment and the importance of building a positive and respectful relationship with the natural world.

Readability of ecology learning materials
The survey results indicated that most students (89%) preferred utilizing printed learning materials, while 11% selected for digital materials. The preference for printed materials is

motivated by various factors, including the absence of Internet constraints, allowing for focused and sustained learning. Additionally, they reduce eye fatigue, which can result from continuous learning on laptops or mobile devices, and offer clearer and larger fonts and sizes. Another benefit of printed materials is that students can highlight and annotate important concepts. Interestingly, the study found that students also valued the convenience and comfort provided by the type of paper used in printed learning materials, despite the increasing prevalence of digital technologies.

Related to the accuracy of the placement of illustrations and images of text, 72% of students stated that the text was in accordance with the image, both in placement and explanation of the material. Meanwhile, 28% students stated the text was very long and placed far from the image because it did not explain its concept directly.

### Effectiveness of providing links to external resources

When creating self-contained learning materials for students, it is crucial to consider multiple aspects, such as the level of mastery required, students' reading abilities and learning outcomes. Therefore, learning materials can be enriched with relevant and up-to-date materials. One effective strategy is to include links to environmental issues and enrichment materials corresponding to each ecology concept, leveraging external resources available on various educational websites. These resources can be readily accessed through Internet pages. The survey results through a questionnaire on the use of external resource links on digital learning materials are shown in Figure 3.

Figure 3 shows that all students successfully accessed the external resources in the learning materials and found these materials relevant to the course. As many as 79% of the students found the ecology presented in the external resources interesting and helpful. However, some students reported issues such as finding the process very long and boring (14%) with difficulty in understanding due to language barriers (7%). It is important to note that the length of ecology concepts cannot be easily shortened, and using external resources from websites requires the content to be presented in its entirety. Meanwhile, in-depth interviews and trials with 21 selected students revealed that including external resources on printed learning materials was less efficient, as students had to write down one after another.

Discussion

Content validation

Providing interesting and practical examples can inspire students to apply ecology concepts in their daily lives and work. Technology is often inspired by natural phenomena such as the
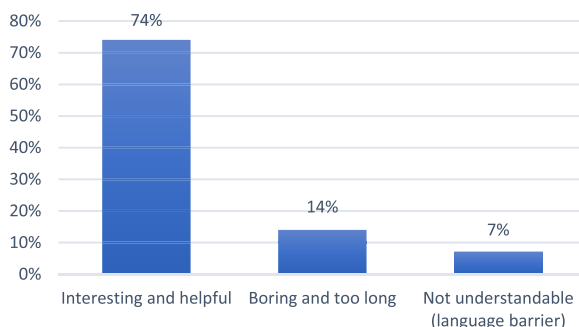
Source(s): Figure by authors

Figure 3.
Students' opinion on
external resources
links in ecology course

submarine sonar system developed from the dolphin sonar (Pailhas *et al.*, 2012) or sustainable energy sources modeled after the hummingbird-wing structure (Ahmed *et al.*, 2017). Introducing such examples can help students understand the behavior of living things and ecology values. It also highlights how deposits of plants and animals, which lived millions of years ago, led to the formation of petroleum, natural gas and coal beneficial to humans today. This increased curiosity and motivation to explore, question, investigate and understand how nature works. This can result in a high sense of responsibility for preserving nature while producing technology to meet human needs.

In current ecology, the relationship between organisms and their environment is highly interconnected, forming ecosystems. Meanwhile, the existing learning materials provide valuable insights into these ecosystems. It is also important to highlight current environmental challenges, such as climate change, deforestation, acid rain and other related issues. Students can be inspired to apply ecology principles to address these real-life problems by providing examples of problem-solving strategies.

These various ecosystem issues have garnered global attention and are widely discussed in mass media and among studies from various disciplines. Topics such as eco-anxiety, climate anxiety, pollution, environmental crises and clean water availability must be included in learning materials to help students achieve their learning goals. Additionally, photography and art can enhance students' learning abilities, achievement and problem-solving skills (Phungsuk *et al.*, 2017).

To ensure the relevance of ecology concepts, it is crucial to provide examples that students can apply to their respective work contexts. According to the 2019 Biology Study Program tracer study, 70% students are already employed, which means they can readily utilize ecology concepts to benefit their environment. The diverse professional backgrounds of students who take ecology courses, including the pharmaceutical industry, plant quarantine, laboratory assistants, health workers, air analysis and related fields (Hewindati, 2020), make it even more important to select examples that are designed to their specific needs. Given the close relationship between ecology and environmental science, a holistic discussion from various perspectives is necessary. Chamany *et al.* (2008) further emphasized the importance of including social issues in ecology learning. In order to enrich students' understanding and foster innovation in applying ecology concepts to their work, examples must be accompanied by reviews and explanations from multiple viewpoints.

Incorporating values and ethics is an essential aspect of ecology implementation, as an ecologist expert suggested (Purwanto, Y., UNESCO, personal communication, September 13, 2021). Rapid technological development and population growth exert tremendous pressure on ecosystems, disrupting reciprocal relationships and potentially impacting energy cycle, food chains and biogeochemical processes. Ecosystems provide vital resources, such as food, clean water, shelter, air, etc, that sustain human life. Humans often fail to recognize their interconnectedness with the environment, leading to significant anthropogenic damage and the greatest harm to ecosystems. Therefore, it is crucial to integrate values and ethics in ecology education and implementation to foster a deeper understanding of human–nature relationships and promote responsible environmental stewardship.

The impact of human activities on the ecosystem is substantial, including overexploitation of natural resources, habitat conversion and modification, species introduction and pollution, among others. These activities, directly and indirectly, affect ecosystems, leading to environmental degradation and biodiversity loss. Climate change also poses a significant challenge to the ecosystem, affecting water availability, food security and health (Flint, 2013). In order to promote a more comprehensive understanding of the ecosystem, the concept of reciprocal relationships should be supplemented with information on the ecology, intrinsic, economic and ethical values of biodiversity in ecosystems, as well as perceiving indigenous knowledge as cultural heritage. This multifaceted approach can help

underscore the importance of preserving ecosystems and motivate individuals to take responsible actions to protect the environment.

In managing the ecosystem, ethical considerations are crucial due to their close connection to human activity. Meanwhile, examples can be presented to raise awareness and empathy towards the environment, such as pictures of human activities that negatively impact ecosystems, such as encroachment, illegal logging, hunting, etc. It is important to provide several alternative solutions to these problems. In addition to linking ecology concepts and principles with problem-solving, ecologists recommend incorporating values and ethics into each implementation to promote environmental sensitivity, particularly among decision-makers. This process will enable people to better understand the interconnectedness between human activity and ecosystem health and make responsible decisions that prioritize sustainability.

Sustainable development and SDGs are inseparable from the ecosystem, as the environment serves as the fundamental basis for human progress and the well-being of all living things on earth. However, imparting knowledge about sustainable development to students, including SDGs-related materials in their learning materials, would be useful. It is equally important to pinpoint to students that SDGs are global, universal, integrated, peaceful, inclusive, and grounded in values and ethics crucial for managing ecosystems. When providing examples of SDGs implementation, it is crucial to consider human rights and complex humanitarian issues at the local, national and global levels from various perspectives to foster a sense of responsibility among students in making informed decisions and taking action.

Readability

Readability is essential in achieving competencies and maximizing learning time for students in a distance education system. Recent studies emphasized the importance of text features and their ease of comprehension (DuBay, 2004). Furthermore, Abrosymova (2021) argued that readability referred to the ease of reading and the readers' ability to understand the text. There is limited study on the readability of ecology books for distance education students scheduled for independent study.

The survey revealed that 89% of the students preferred using printed learning materials compared to only 11% choose digital learning materials. Students who preferred printed learning materials cited various reasons, including limited Internet access and the inconvenience of reading from cell phones. The lack of a reliable Internet connection made it difficult to read digital materials. Printed learning materials provided the advantage of studying from different locations without the constraint of Internet availability.

The students opt for printed version of learning materials primarily because they are clearer, and the font size is larger compared to digital learning materials accessed through smartphones, as reported by 79% of the respondents. Moreover, 21% of respondents preferred printed learning materials because the learning materials could be highlighted and annotated, using an effective learning strategy that boosts engagement, understanding and retention of key concepts (Stoop *et al.*, 2013; Mizrachi *et al.*, 2018). Preliminary studies showed that annotations and highlighting help students identify paragraph structure and improve their understanding of complex chemistry textbooks (Azmuddin *et al.*, 2020). Some students still preferred digital learning materials due to the practicality of being able to access at any time and place as well as add notes directly in the book. Additionally, the use of color illustrations in digital materials is also preferred by some students.

When engaging in discussions with students, it is noteworthy to consider their feedback regarding the type of paper utilized in printed learning material. During a focus group discussion involving students, all participants stated that they found the paper used to be comfortable without causing any undue strain. The printed learning materials produced by Universitas Terbuka employed "book paper", a type of high-quality beige paper that minimizes glare, thereby reducing the likelihood of eye fatigue.

Universitas Terbuka, as a remote learning service provider, offers various accessible services to students, including online services. The COVID-19 pandemic has made digital learning materials the primary mode of delivery for students. According to a survey conducted by the Indonesian Central Statistics Bureau (2021), 62% of the Indonesian population has access to the Internet. However, it is essential to consider Indonesian geographical location, consisting of islands, when providing students with access to learning resources. Although Universitas Terbuka provides digital learning materials that can be accessed online, printed learning materials remain relevant, particularly for students who lack Internet access, specifically those in remote areas.

During the focus group discussion on the appropriateness of illustrations and images to the text, it was revealed that language complexity used to explain concepts could have an impact on readability. The clarity of the text and the accuracy of the image placement and corresponding explanations were identified as factors that influenced readability.

When improving students' concept understanding, providing correct and suitable explanations for images is crucial. Accordingly, selecting the appropriate text to explain the image directly benefits students. This finding is in accordance with Devetak and Vogrinc (2013) research that combining visual-verbal aids and textual explanations was the most effective method for presenting scientific concepts. Similarly, Fatoba's (2015) study on science education found that reading science books could be challenging, particularly biology books, where complex sentence structures and concepts were common. In such cases, using illustrations can significantly enhance students' understanding.

According to students' interviews, using concise language directly related to the subject matter can enhance learning of ecology concepts. Clarity and text length are also factors that influence readability. In the study by Bezirci and Yılmaz (2010) on Science Education textbooks in the field of Biology, it was found that the length of sentences affects readability, with longer sentences, reducing the degree of readability.

Approximately 11% of students prefer digital learning materials because they do not have Internet-related problems. Digital learning materials provide an advantage over printed learning materials as they can display colorful images, which can aid students in understanding complex concepts. On the other hand, printed materials have black-and-white images. Colorful images can provide a more detailed illustration of ecology concepts.

Effectiveness of providing links to external resources
Currently, various ecology concepts and their applications are widely available on the Internet. These concepts are presented through links to certain learning sites, providing students with easy access to information. This convenience benefits study programs, which can easily link to relevant concepts. However, not all external resources are suitable for efficient studying, and selecting the right website can be challenging. Students need to consider their competency level and select high-quality ecology concepts. It is also necessary to acquire a license in order to use these concepts.

When selecting links for learning resources, it is essential to consider their relevance, contextual content, but also the quality of the material. Some learning websites, such as Khan Academy and Bozeman Sciences, are excellent sources of information and frequently used as links to ecology learning materials. In higher education, videos are a critical component of delivering scientific content, whether blended or online learning, in higher education (Brame, 2017). It was further reported that videos can provide a unique advantage for students' preparation in biology courses, as they find them more engaging. Additionally, Stockwell *et al.* (2015) highlighted the special value of videos in this context, suggesting that they can be particularly useful for students' preparation for biology courses and their learning interests.

Providing enrichment materials through links within learning resources can benefit students who rely solely on printed materials. These additional resources can help students

better understand the various concepts and clarify information. However, the results of the focus group discussions and in-depth interviews with students showed that while all students have access to external resources, it may take a considerable amount of time. For students who rely only on printed materials, it is essential to carefully and accurately write down the website addresses before attempting to browse on a computer device.

Although external resources can be valuable in ecology learning materials, students who rely on printed materials may encounter difficulties accessing Uniform Resource Locator (URL) links. Many students find it challenging and inefficient to manually transfer the URL address from external links onto their devices for browsing. Moreover, typing the link addresses, manually result in numerous errors, rendering external resources inaccessible. During the focus group discussion, students proposed using scannable links on printed learning materials to facilitate accessibility. The use of scannable links can enable students to access external resources quickly and easily.

The impact of increasingly advanced information technology is undeniable, and it has brought about rapid changes, such as increase in the competence of graduates and the application of information technology across all sectors. Students accessing digital learning materials see external resources as an excellent strategy for enrichment and inspiration (79%), but careful consideration must be given to selecting a license. According to students, some external materials can be too lengthy, and not all ecology concepts are relevant for clarifying theoretical concepts (14%). Additionally, some students struggle to understand external resources written in English (7%), as they are often sourced from freely available open-source materials. Language ability is a crucial factor in determining the readability of the readers, as noted by Fatoba (2015). Adding Indonesian subtitles to ecology concepts in external resources presents a challenge for the Biology Study Program. Another alternative is to selectively use external resources, with licenses that allow for moderation, such as CC BY-NC-SA.

Side findings from students' interviews
This study revealed an interesting aspect of students' learning style, which was their tendency to start studying the learning materials from various sections. The majority of students (68%) preferred to start by reading the descriptions and examples, before delving further into the content. On the other hand, 15% students began with the summary, while 17% started with the introduction. The display of the learning materials was visually appealing and straightforward, incorporating covers, layouts, pictures and videos that explained ecology concepts. The learning materials' legibility was intertwined with their appearance and layout, with 30% students finding the module display very attractive, 64% finding it interesting and 6% considering it normal.

Conclusion
Based on the review by the ecology experts, it is imperative to incorporate examples of environmental issues in the learning materials to enhance students' motivation and understanding of ecology concepts. The inclusion of various examples of biological phenomena can inspire and benefit the development of science and technology. Additionally, the learning materials should emphasize the ecology principles of SDGs to provide students with a comprehensive understanding of the global, universal, integrated, peaceful and inclusive concept. The ethics and values associated with managing ecosystems should be taught to foster a sense of responsibility in decision-making.

In accordance with the analysis of students' feedback on the readability of ecology learning materials, the overall layout of the materials is highly readable, which is beneficial to students learning process. About 32% students expressed a high level of satisfaction with the readability of the materials, attributing it to the quality of the paper used, the clear type and

size of the text used, and the philosophic reflection of the cover design that showcases the diversity of species in different ecosystems. However, some students found the language used in the materials to be lengthy and difficult to comprehend, highlighting the need for further study to explore the language composition and its ease of understanding.

It is recommended to add Indonesian subtitles to external resources that serve as enrichment materials and exemplify the implementation of ecology concepts. Alternatively, Universitas Terbuka, as a distance learning institution, should develop its materials and videos. The study results suggested that external resources were highly valuable in promoting the understanding of ecology concepts and enhancing their practical application, including Quick Response (QR) codes on printed learning materials might improve access to these resources.

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