Research Article

Topics of Ecology Course in Preparing STEM-based Module

Tutut Indah Sulistiyowati[1*]**, Farida Nurlaila Zunaidah**[1]**, Susriyati Mahanal**[2]**, Siti Zubaidah**[2]**, Ida Rahmawati**[1]

[1]*Department of Biology Education, Universitas Nusantara PGRI Kediri, Jl. KH Ahmad Dahlan 76 Kediri, East Java 64112, Indonesia*
[2]*Department of Biology, Universitas Negeri Malang, Jl. Semarang No. 100 Malang, East Java 65145, Indonesia*

ORCID
Tutut Indah Sulistyowati: https://orcid.org/0000-0002-6341-3019
Farida Nurlaila Zunaidah: https://orcid.org/0000-0003-4811-8377
Susriyati Mahanal: https://orcid.org/0000-0001-5764-2184
Siti Zubaidah: https://orcid.org/0000-0002-0718-6392
Ida Rahmawati: https://orcid.org/0000-0002-6819-1830

Abstract.

Ecology is a compulsory course for students of Bachelors' Degree in Biology Department. The course lecture includes theories and practices. During the delivery of theories, content conveyed to the students must be in accordance with the course characteristics. Based on interview results, students considered some of the contents to be difficult. The research aims to select topics in Ecology course as a basis for developing STEM (Science, Technique, Engineering, Mathematics)-based module. The expectation is that students could gain a better understanding after the implementation of the STEM-based module approach. The research is qualitative research with a survey method. The data collection were done using survey questionnaire on Google Form platform. The data analysis technique was carried out by elaborating the questionnaire survey results regarding content requirement of the Ecology course. The research finds that several contents delivered in the Ecology course are deemed as difficult. The contents include biogeochemical cycles as well as energy and productivity.

Keywords: ecology, course, STEM-based module

1. INTRODUCTION

Ecology is one of compulsory courses in the Department of Biology. The course lecture consists of two stages, namely theory and field practice. In the theory presentation stage, the course is usually supported by the content-related learning sources. The learning sources can be in the form of teaching materials adjusted to student needs. The teaching materials used include reference books or the course modules. Teaching materials have a significant role in delivering course content, as it facilitates lecturers to share knowledge to students [1]. Lecturers usually have reference books to share with

students related to the course they taught. Likewise, lecturers have several references in Ecology course that suitable to content delivered to students.

Topics delivered to students have been adjusted to the existing course requirement. Contents in the topics are adapted to the topic title. The contents are delivered in simple language so that students could easily understand. Each topic presented has its own objectives according to its discussion [2]. Topics discussed in a lecture process must achieve the expected objectives or objectives designed in the topics. This is due to the benchmark of success in a topic delivery is the achievement of the topic objectives [3].

An observation conducted by distributing questionnaire to students of Biology Education results in that there are several content topics that are considered important and students sort the content from the most difficult to the easiest. Content delivered in the ecology course consist of several topics of discussion. Topics related to ecology is varied [4] that include ecological scope, individual, population, community, and ecosystem, energy in ecological system, biogeochemical cycles, habitat and ecosystem conservation. All topics are delivered periodically according to the existing course schedule. Topics in Ecology course has varying degrees of difficulty depending on the content discussed [5]. Diversity of difficulty level in the topics depends on content, discussion, and compilation of sentences in ecology teaching materials [6]. Oftentimes, hard-to-understand language renders difficulties to students to learn contents in the ecology course. Therefore, teaching materials that are adjusted to topic of discussion in ecology and students' needs and characteristics are necessary [7]. This aims at facilitating students to understand content delivered and encouraging them in participating in the lecture and working on assignments given by the lecturers.

Teaching material development that is considered suitable to student learning is module. Module is a set of several contents along with exercises and certain case studies that are systematically arranged so that it can be used as a teaching guideline for lectures and as a tool for students' independent learning [8]. In ecology module to be developed, several topics of discussion suitable to the course characteristics and students' need are taken. The selection of topics of survey-based ecology module has led to a STEM-based module. Ecology is a science and its lecture implementation has been supported by engineering, technologies, and mathematics related to the application of the engineering and technologies. Ecology lectures have employed interesting techniques as it can be conducted inside and outside the class. The need of technology in ecology lecture is increasing, for example, the use of electronic modules and other internet accesses to support the lecture. The ecology lecture contains mathematic element related to certain calculation using formula employed in ecology [9]. Not all

topics in ecology lecture, however, can be delivered using STEM approach; therefore, a study on topic selection in ecology course that can be delivered using STEM (Science, Technology, Engineering, Mathematics) approach need to be conducted. The research is urgent because not all learning achievements in the Ecology course topics can be taught using the STEM approach. The module characteristics are personal, self-instructional, it can be used independently, and it includes direct and independent self-assessment (evaluation) part [9, 10]. Therefore, it is necessary to perform prior research to determine topics in ecology study suitable to be presenting in STEM-based module. The research will produce a topic mapping in ecology study presentable in a module using the STEM approach.

2. RESEARCH METHOD

The research was a qualitative research using survey method. The research sample consisted of 104 students from three University in East Java who enrolled in ecology course. The survey carried out in March-April 2020. Data collection technique used survey questionnaire. The data collection instruments included 1) survey questionnaire using Google Form platform as it deemed practical and efficient to generate accurate results and easy to read and 2) interview guideline with lecturers who taught ecology course. Questions in the questionnaire consisted of 1) how important the teaching materials are in supporting ecology lectures? 2) is the existing teaching material easy to understand? 3) Are the referenced teaching materials suitable to your need? 4) Are topics discussed suitable to ecological realm? 5) What topics are usually presented in ecology course? 6) which content do you find the most difficult to the easiest to understand?

Data analysis technique elaborated the survey questionnaire related to topics of discussion of ecology that were deemed important and difficult to understand by students. The survey result data will be explained in sentences that described the students' needs regarding topics of discussion in ecology course that will be a basis in developing a STEM-based ecology module.

A research team in a Forum Group Discussion (FGD) compiles the research instruments. The research data collection uses instruments determined as suitable by the expert team. As many as 104 students are selected as respondents. The students come from three cities in East Java – Kediri, Blitar, and Tulungangung. The distribution of respondents based on gender is illustrated in Figure 1. The figure shows that 61 students

from Kediri consist of 23 male and 38 female, 33 students from Tulungagung comprises 5 male and 28 female, whereas students from Blitar consist of 1 male and 9 female.
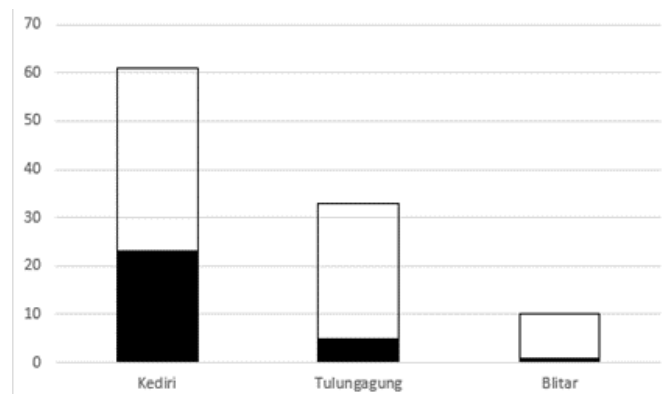

Figure 1: Distribution of respondents based on gender: Open bar for male respondents, closed bar for female respondents.

3. RESULT AND DISCUSSION

Ecology lecture process requires teaching materials suitable to student needs. Teaching materials used contain topics of discussion related to ecology content taught by the lecturers. The topics presented have various difficulty levels. Based on data, about 64% respondents stated that content of biogeochemical cycles is hard to understand. It was indicated by complicated description about the content. The content is indeed complicated and complex. It contains various explanations that must be understood sequentially so that students could understand the supporting components and processes in the biogeochemical cycles [11]. Students must fully understand cycle after cycle in the biogeochemical cycles to be able to explain it correctly and better.

About 41.2% respondents stated that the second difficult content is energy and productivity. This content is similar to biogeochemical cycles for students must understand the meaning of energy and the energy changes. The energy change process in organism is varied. This affects productivity of the organism. Students must understand components that influence productivity and its results [12]. Further, 21.6% of respondents stated that the third difficult content is habitat and ecosystem conservation. The content is not as complicated as the previous two contents. In this content, students need to understand a variety of organism habitat, things to be done to preserve the habitats, and ecosystem conservation applied in preserving the endangered organism. Students, in this content, must understand various habitats and conduct direct observation survey. Diversity in habitats will influence ecosystem conservation in an environment.

Other contents that required teaching materials suitable to student needs included individual, population, community, and ecosystem (17.6%) and scope of ecology (5.9%). These contents will be included in the topics of discussion of STEM- based ecology module development. The module development was based on respondents' opinion stating that they need teaching materials that have the following elements. (1) All chapters are included in one book; (2) It contains formulation of explicit learning objectives; (3) It systematically lists association, structure, and order of knowledge; (4) It requires students to learn actively; (5) Self-instructional can be used independently; and (6) It is practical to be carried everywhere and to be used any time for learning.

Elements selected by the respondents describe STEM model in the module development. STEM combines four different elements that creates a lecture module that is innovative, portable, can be used for independent learning, accessible at anytime, easy to understand by students, and triggers interest in independent learning among students [13]. In STEM, ecology includes in science element and science learning requires innovative teaching techniques that include teaching in the classroom and outside the classroom [14]. To support the ecology lecture according to current development and demands will require accessible technology. The existing technologies are expected to simplify students in learning contents in ecology learning. The technology that can be produced is by using electronic module (e-module) so it can be access anytime and anywhere [15]. Moreover, the cultivation of mathematics element is also found in several ecology contents that require calculation of certain elements to generate accurate ecological data [16]. The development of the STEM-based ecology module is expected to give new colour in the ecology process and improve interest in independent learning among students of Biology Education.

The analysis of respondent results and the suitability to the content and module characteristics finds that not all topics in the Ecology course can be presented in the STEM-based module (Table 1). Some contents can be taught using the STEM approach yet they cannot be presented in the module since they require instructions and direct supervision from the lecturers [17, 18].

Table 1 indicates that not all discussion topics in ecology can be done using the STEM approach. For example, the topic of environmental factor concepts can only be approached using science and technology, whereas it is hard to find engineering and mathematics concepts in the topic. It also prevails for other topics. Therefore, it can be stated that five topics can be taught using STEM approach and presented in the module, namely the Scope of Ecology, Energy in Ecological Systems, Productivity, Biogeochemical Cycles, and Ecology of Habitats.

TABLE 1: Compatibility of topic on ecology course with stem based module.

Topic	Learning Achievement	STEM	Module
Scope of Ecology	Students are able to explain and analyze concepts, components, and examples of ecosystems	STEM	V
Energy in ecological systems	Students are able to explain and analyze the occurrence of energy in an ecosystem	STEM	V
Productivity	Students are able to estimate and design a simple measuring instrument for plant respiration	STEM	V
Biogeochemical cycles	Students are skilled at creating and compiling a biogeochemical cycle diagram independently and responsibly	STEM	V
Environmental factor concepts	Students are able to explain state factors and interactive control and the general description of environmental factors	S, T	V
Community	Students are able to explain community concepts and patterns	S, T, M	V
Population	Students are able to measure population density, calculate population growth, and explain population interactions	S, T, M	V
Types and individuals in a population	Students are able to explain micro- and macro-habitat concepts	S, M	V
Ecology of habitats	Students are able to differentiate the ecology of freshwater, marine, terrestrial, and estuary and connect them with the ecological conservation concept	STEM	V

4. CONCLUSION

The research found that there were several contents that were deemed difficult up to easy by the respondents, namely biogeochemical cycles (64.7%), energy and productivity (41.2%), habitat and ecosystem conservation (21.6%), individual, population, community, and ecosystem (17.6%), and scope of ecology (5.9%). These contents should be included in the topics of discussion in the development of STEM- based module. The development of STEM-based ecology module was based on student opinions that they require learning sources that have the following elements; 1) all chapters are included in one book; 2) it contains formulation of explicit learning objectives; 3) it systematically lists association, structure, and order of knowledge; 4) it requires students to learn actively; 5) Self-instructional can be used independently; and 6) it is practical to be carried everywhere and to be used any time for learning.

References

[1] Setiawan B, Dores OJ. Pengembangan bahan ajar berbasis keterampilan metakognisi dalam upaya meningkatkan kemampuan literasi matematis mahasiswa. Jurnal Pendidikan Matematika Indonesia. 2019;4(2):68–72.

[2] Sinambela M, Sinaga T. Pengembangan bahan ajar biologi umum sebagai sumber belajar untuk buku peganggan mahasiswa. Jurnal Pelita Pendidikan. 2020;8(3):189–94.

[3] Ardiansyah R, Corebima AD, Rohman F. "Analisis kebutuhan pengembangan bahan ajar perubahan materi genetik pada matakuliah genetika di universitas negeri malang.," In: Prosiding SNPBS (Seminar Nasional Pendidikan Biologi dan Saintek). pp. 749–752 (2016).

[4] Indriaty I, Setyoko S. Pengembangan bahan ajar ekologi hewan berbasis problem based learning di program studi pendidikan biologi universitas samudra. Jurnal IPA & Pembelajaran IPA. 2018;2(1):29–35.

[5] Desy R, Setyoko S. Pengembangan pembelajaran blended learning berbasis website di program studi pendidikan biologi universitas samudra. Jurnal Pendidikan Biologi. 2017;6(3):346–50.

[6] Safnowandi S. Keanekaragaman plankton di pantai jeranjang kabupaten lombok barat untuk penyusunan modul ekologi hewan. JUPE : Jurnal Pendidikan Mandala. 2019;4(5):195–201.

[7] Winarti Y, Indriyanti DR, Rahayu ES. Pengembangan bahan ajar ekologi kurikulum 2013 bermuatan sets melalui penerapan model problem based learning. Unnes Science Education Journal. 2016;5(1):1070–8.

[8] Budiono E, Susanto H. Penyusunan dan penggunaan modul pembelajaran berdasar kurikulum berbasis kompetensi sub pokok bahasan analisa kuantitatif untuk soal-soal dinamika sederhana pada kelas x semester i sma. Jurnal Pendidikan Fisika Indonesia. 2006;4(2):79–87.

[9] Haristah H, Azka A, Setyawati RD, Albab IU. "Pengembangan modul pembelajaran.," Imajiner: Jurnal Matematika dan Pendidikan Matematika. vol. 1, no. 5, pp. 224–236, 2019.

[10] Sudirman, Kistiono, and Taufiq, "Pengembangan modul mata kuliah gelombang berbasis stem (science, technology, engineering and mathematics) pada program studi pendidikan fisika.," Jurnal Inovasi dan Pembelajaran Fisika. vol. 5, no. 2, pp. 134–140, 2018.

[11] Herdianawati S. Pengembangan lembar kegiatan siswa (lks) inkuiri berbasis berpikir kritis pada materi daur biogeokimia kelas x [BioEdu]. Berkala Ilmiah Pendidikan Biologi. 2013;2(1):99–102.

[12] Sari IP, Abadi S, Nawawi S. "Pengembangan modul pembelajaran biologi berbasis problem solving pada materi ekologi.," Best Journal (Biology Education Science & Technology). vol. 4, no. 1, pp. 25–31, 2021.

[13] Arisya F, Haryati S, Holiwarni B. Pengembangan modul berbasis stem (science, technology, engineering and mathematics) pada materi sifat koligatif larutan. Jurnal Pendidikan Kimia Universitas Riau. 2021;6(1):37–44.

[14] Oktavia R. Bahan ajar berbasis science, technology, engineering, mathematics (stem) untuk mendukung pembelajaran ipa terpadu. Jurnal SEMESTA Pendidikan IPA. 2018;2(1):32–6.

[15] Setyoko S, Rohman F, Suwono H. Development of animals ecology module for macrozoobentos community at higher institution [Jurnal Pendidikan Biologi Indonesia]. JPBI. 2017;3(1):80–7.

[16] Syahirah M, Anwar L, Holiwarni B. Pengembangan modul berbasis stem (science, technology, engineering and mathematics) pada pokok bahasan elektrokimia. Jurnal Pijar Mipa. 2020;15(4):317–24.

[17] Stewart JL, Wilkerson VL. A guide to teaching with modules. Hope College: Fall, Washington DC, 1999.

[18] Donnelly R, Fitzmaurice M. "Designing modules for learning.," In: G. O'Neill, S. Moore & B. McMullin(eds.). pp. 1–21. Emerging issues in the practice of University Learning and Teaching, Dublin, All Ireland Society for Higher Education (AISHE) (2005).