Jurnal Penelitian dan Pembelajaran IPA JPPI
Vol.8, No.2, 2022, p. 192-204 p-ISSN 2477-1422 e-ISSN 2477-2038

Development of a Biotechnology Module to Improve Science Communication Skills Toward Society 5.0

(Received 8 October 2022; Revised 23 November 2022; Accepted 23 November 2022)

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DOI: 10.30870/jppi.v8i2.17227

Abstract

The need for teachers who are proficient in communicating science face-to-face and making flexible use of various integrative media is increasing along with changes in community communication patterns. High scientific communication skills can support learning with topics closely related to the latest technology, such as biotechnology. This study aims to develop a multimedia-based biotechnology module using Canva as a learning source to increase prospective science teachers in Science Education Department in science communication skills toward Society 5.0 era. As a result, the learning resource developed as a Biotechnology module for S1 Science Education students contains integrated biotechnology content. It presents learning activity guides, quizzes, and assignments that support prospective teachers in developing science communication skills in the classroom. Validation results from material and media experts indicate that this module is valid and feasible to be applied in biotechnology learning for prospective science teachers.

Keywords: Biotechnology, Community 5.0, Science Communication Skills

INTRODUCTION

In the last five years, changes in communication patterns in society globally, along with the rapid development of the internet, require the purposive teacher to adapt. The Society 5.0 era will combine digital technology and the internet with traditional industries to comprehensively transform all aspects of industrial production and education (Nair, 2021; Togo, 2021; Navaes Rojas, 2021). Living in Society 5.0 means, instead of running all systems separately. Society 5.0 introduced a working system to ensure everything is integrated into society as a whole supply chain system, such as energy, transportation, medical care, shopping, education, work, and leisure. The system must collect diverse and rich data from the real world. This data needs to be processed by advanced IT systems such as AI. This is because only these IT systems can handle large amounts of data (Deguchi et al., 2021).

As technology advances, the teacher must have the capability and confidence to explain a complex concept using any form of communication media to their students and non-scientific audience. The learning process that evolves according to technological developments encourages prospective teachers to be more creative in their communication efforts during science class (Al Lily, et al, 2020). However, some research have been done shown that it is unlikely that the pre-service teacher will develop these skills without deliberate instruction (Claro, M., et al. 2018).

It is also worth noting that the enhancement and development of such skills, problem-solving, critical thinking, interpersonal skills, and creativity, are of great importance in education (Darmaji et al., 2019; Carayannis et al., 2022). It is also necessary to design educational environments that provide opportunities to link theoretical training to practical situations. It is therefore recommended to create an appropriate training environment, apply modern skill training methods, and meet the need to improve current methods (Ishak, 2022). There is a need to apply modern teaching and training methods, including positive, student-centered methods.

The development of education to prepare prospective teachers to face their role toward Society 5.0 is inevitable. Improvement and development must be carried out by existing needs to maintain the quality and needs of human resources. However, there needs to be more appreciated for a prospective teacher to learn methods of effective science communication. The curriculum and learning source do not effectively

support the prospective teacher in learning how to gain scientific information and present science concept using easily understood language.

Fortunately, as with any other skill, science communication skills can be trained. This can be achieved by preparing various activity-based learning models that corresponding to competencies and learning materials (Widiarti, A., Muslimin, Yuliani, 2022).

The activity that can train the prospective teacher can include various multidisciplinary approaches (McCullough, 2020). Efforts to train science communication skills can be done with various variations. However, the common thread of all these exercises is to provide opportunities for prospective teachers to carry out related activities and perform simulations to train their abilities and self-confidence (Scalice et al., 2019; Ishihara-Shineha, 2021). Research show that nowadays, the subject of biotechnology is essential. This subject is explained biotechnology as a process of using an organism, components of an organism, or biological system to produce a product or biological agents to run a certain process (Orhan & Sahi., 2018). The learning outcomes are intended to make students summarize the concept of biotechnology as technology, the roles of biotechnology in human life, useful and harmful aspects of biotechnology applications, and future biotechnology applications 21 (Atasoy B. et al., 2020). The increasing number of biotechnology applications makes it important for our generation to be well-informed about it (Pas, 2019). The most challenging part of this subject is understanding the connection between genetics and biotechnology.

Due to its importance, many countries have introduced Biotechnology in their secondary curriculum framework (Hin, 2019). Biotechnology comes in not only one subject but multi-dimensional science. The approach used in this course depends on various types of disciplines (Johnson et al., 2022). Integrating knowledge from various sources requires special skills in analyzing data and information sources, developing conceptual understanding and practical efforts, and delivering in simple language to reach various audiences. Based on these demands, prospective teachers need to be able to identify reliable sources of material to be used in the learning process. Various new concepts that still need to be widely known are also a challenge to present biotechnology as a whole to students.

A learning resource that can help the learning process is a learning module that supports digital learning (Zhu et al.,

2020; Afeyan, 2021). The module is a printed learning resource that contains learning objectives, learning materials, descriptions of activities, task designs, and evaluations (Alsuwaiket et al., 2020). Studies show that electronic modules have been more suitable for blended and hybrid-based learning in recent years (Abou-El-Essoud et al., 2014; Yilmaz et al., 2020). Research shows that using modules helps the habituation of material and coursework to gain certain abilities (Yulastri et al., 2018; Jordaan & Mennega N, 2021; Ssentamu et al., 2020).

We designed a new, integrated, multimedia-based module to improve science communication skills and grow student knowledge in biotechnology. The development target is to provide learning resources that support improving of science communication skills to prepare purposive science teachers to meet their role as teachers for the community 5.0 Era.

METHOD

This research was conducted as a part of the Research and Development methodology modified from Borg and Gall (1983). This methodology is conducted to produce a certain product and evaluate its effectiveness (Sugiyono, 2010). The steps taken in the research explained in this article results are: 1) searching for potential and problem; 2) collecting information; 3) product design; 4) design validation; and 5) revision and improvement.

The data analysis technique was carried out as quantitative and qualitative analysis. We measured the validity of the developed product by collaborating with one lecturer in the biotechnology course as a material expert assessor and one learning media expert lecturer as an expert judge from the aspect of learning media. The quantitative analysis describes the validity index of the Biotechnology module for a prospective undergraduate teacher. The questionnaire for the validity test uses the Likert scale modified with four alternative answers adapted from Luthfi et al. (2017), as explained below.

3.25-4.00: Credible
2.20-3.24: Valid
1.75-2.48: Poor
1.00-1.74: Invalid

In the qualitative analysis, we use the response of the validators in the form of decisions and improvements toward the integrative biotechnology module.

RESULTS AND DISCUSSION

Implementation of research on developing biotechnology learning modules for students of S-1 Science Education begins by exploring the problems that exist in learning biotechnology courses in the science education study program at one

university in Banten, Indonesia. The results of our preliminary research reveal that the greatest obstacle to studying biotechnology to help students develop science communication skills is need for more learning resources to support their skills. Optimizing student skills can be achieved by communicating scientific information to diverse audiences (Kelp &Hubbart, 2021).

From these results, we designed a module to convey information about biotechnology and its applications. The first step in designing this module is to fit the needs analysis results into the module's design framework to be developed. It is hoped that the content developed will support the learning process and the needs of prospective teachers in building early knowledge and exploring key material. Based on the research, we have divided the module into six chapters, which are listed in Table 1.

Table 1. Content of the biotechnology module

Chapter	Topics
1	Principle and development of Biotechnology
2	Food Biotechnology
3	Agriculture biotechnology
4	Genetics materials and modern biotechnology
5	Modern Biotechnology in life
6	Ethics in Biotechnology

With the content list compiled, we began creating content and designing appropriate learning activities to help prospective teachers improve their science communication skills. As the modules are developed as multimedia sources, we also develop audiovisual content to help explain existing concepts. Basic concepts are presented in discourse, and supplementary material can be explored in audiovisual content. To present material with a better visual appearance, we use Canva as a tool in designing modules and content. The final design is in Figure 1.

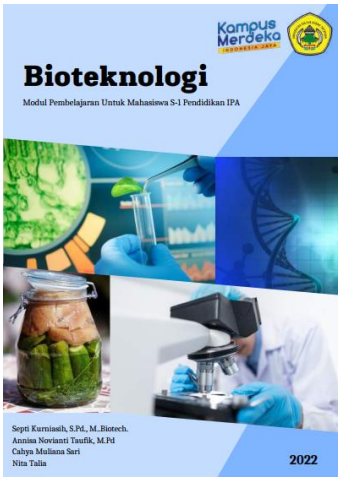

Figure 1. The final design of the Biotechnology module for prospective science teacher

The material in this module is arranged to support a case-based and project team-based method, the method used in the biotechnology course in the Science Education Department at one university in Banten, Indonesia. At the beginning of the chapter, phenomena, and cases related to the theme are presented. From the existing cases, the narration and delivery of material are directed to the main concepts to be

studied. This section is also designed to attract the attention of pre-service teachers to explore how the concept and application of biotechnology should be conveyed to students. inviting preservice teachers to study important phenomena related to biotechnology in everyday life will help them build a sense of belonging and maintain motivation in the learning process (Smalley, S. et al. 2019; Membrillo-Hernandez, J. et al. 2019). With this flow, it is expected that students are trained to be critical of literary sources before reaching certain concept conclusions. Case-based learning helps students to improve students self-directed learning (Rezaee & Mosalanejad, 2015).

Training prospective teachers to teach science requires space for expression and practice through activities that stimulate curiosity and interest in teaching theory and putting skills into practice. Thus, some characteristics of activities considered suitable for improving communication skills are presented. Science communication skills training is required, including the ability to gather information, manage information and content, control attitudes toward information, and communicate information according to the cognitive level of the audience and media that support the transmission of information and knowledge (Baram-Tsabari & Lewenstein, 2017; Besley et al., 2017; Bennet et al., 2019).

To help students have this experience, we provide supporting activities such as a discussion corner, which helps students discuss cases and the results of material exploration before class starts in small groups. This feature aims to initiate the process of information seeking and discussion to manage the information obtained. The discussion process with study partners in small groups can improve understanding of concepts, student participation in the process of managing information, and engagement in problem-solving (Chen et al., 2021; Windschitl et al., 2020). The prospective science teacher can also promote their oral communication skills using various ways in the discussion progress (Purnomo, 2018).

The second feature is "Let us make a Project" which aims to invite students to have experience in designing a concept of delivering scientific information through various types of media. It is to practice their skills in conveying concepts through interactive audiovisual media, often used in the Society 5.0 Era. The huge shift from raditional to digital approaches in science education context has turned the way pre-service teacher should sharpen their communication skills through various interactive learning media (Alt, D. 2018).

Characteristics of information media that will be popular in the world of education in the era of Society 5.0 are media that support audiovisual, interactive, freely accessible in time and place, and based on AI (Roblek et al., 2020). The media developed are various, ranging from written, visual, and audiovisual media. It is hoped that with these variations, prospective teachers can master one type of communication skill and communicate widely through various media.

The evaluation stage is one of the most crucial stages in learning. Evaluation is done to see how the development of the students after the learning process is carried out. We present an evaluation process that not only focuses on how students understand the material and concepts given on a topic but also evaluates students' affective and skills in applying each stage of good science communication. Good evaluation is related to the quality of the student experience and engagement (Holmes, 2015). The formative evaluation is divided into six, according to the topics presented. In each of these evaluations, a project is developed that must be carried out individually and in groups. The individual evaluation focuses on how students internalize information from credible sources. Evaluation in the form of a project reviews students' ability to present scientific information in written, oral, or audiovisual form. This project requires students to be able to collaborate and present content in a simple form according to the cognitive level of students that will be faced. Critical and creative abilities towards phenomena and cases in the biotechnology field are also honed, where students are required to present concepts creatively to achieve maximum engagement with the audience.

A module validation test was conducted by material and media experts who are university science and teaching practitioners. From the validation process, the results are shown in the diagram in Table 2.

Table 2. Validation result of biotechnology module by experts

Aspect	Average score
Material aspect	
Content eligibility	3
Science Communication Skills	3
Material delivery	3,4
Accuracy and update	3
Language features	3,5
Media Aspect	
Graphical	3,3
Display and view	3,5
practicality	3,3
Utility	3,8
Consistency	3.4

Based on the material expert's validity test, they knew that the module categories were valid in content eligibility, science communication skills, and material accuracy and update

aspects. Thus, the material delivery and language features categorize the content as credible. The result shows that the module can use as a learning material but needs to improve, especially in these three aspects. Revisions were made to provide advice from material experts, which are providing the latest journal-based information, processing terms and patterns of content delivery, and dividing assignment patterns to be more in line to improve the communication skills of prospective science teachers.

The module biotechnology has been developed and then analyzed from the media expert side, to assess the quality of the module as learning media. Table 2 shows that the module in each aspect is categorized as credible, with a score of more than 3,25. However, there is advice from the media expert to develop the module better.

Continuous improvement and development to obtain maximum quality results are carried out to present the best modules for prospective teachers. It is part of self-development in the learning process. Suggestions from experts and literature studies are reviewed to find the shortcomings that reduce the quality of the module, which then becomes the material for improvement. The suggestions and improvements we made in Table 3.

Table 3. The suggestions and improvements

Suggestions	Revisions
The biotechnology concept presented is inconsistent with the grand design of biotechnology development	The presentation of biotechnology developments is adapted to standard terms and uses 1 type of definition, to avoid ambiguity
The mechanism for developing science skills needs to be varied	Added a variety of cases and discussion methods to enrich science communication skills
The display of audiovisual media is adjusted to the target, namely prospective teachers	Adjusting the appearance of audiovisual media with the target of prospective teachers
some links are uneasy to open	the link is fixed with the media stored in the internal system, ensuring that the media can be opened
Videos should be displayed with text	Added subtitles in the video supplement

Content improvement is carried out by considering suggestions from material experts. These changes include how information is presented and how activities are arranged to be more appropriate for developing the science communication skills of prospective teachers. Content is improved by being more adapted to the demands of the referred curriculum output (O'neil, 2015). Content is also fixed to avoid

ambiguity. the use of scientific terms is used consistently and accompanied by a glossary to ensure prospective teachers understand the terms used (Franceschini et al., 2016).

In terms of media, improvements include the display. Display of modules appropriate for age and characteristics will increase engagement with the media (Michael, 2016). The design is adapted to the minimalist trend with a blue base color to give a favorable psychological impression. The design adapted to the character of the age of 20 according to the age of the prospective teachers.

Repair of media links is done by changing the Youtube link to Google Drive, considering that the link will enter the closed system and its availability is easy to control. We also provide alternative links in barcodes and clickable links as options for access to related media. The addition of barcodes makes it easier for android users to access learning media (Chen et al., 2013).

CONCLUSION

The biotechnology module developed to improve the science communication skills of prospective teachers is valid and can be implemented in the learning process.

ACKNOWLEDGEMENT

The authors thank LPPM Universitas Sultan Ageng Tirtayasa which funded this research.

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