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Development of Plant Biosystematics E-Module Based on Problem Solving

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Abstract

This study aims to describe the stages of developing the Plant Biosystematics e-module with the 4-D model (four D model) and to analyze the effectiveness of the resulting Plant Biosystematics e-module in improving problem solving skills in students of the Tidar University Biology Education Study Program. The Plant Biosystematics course studies the description, adaptation, and classification of plants, both high and low levels. The research method used is the R&D Model. This model consists of 4 development stages, namely Define, Design, Develop, and Disseminate. The object of this research was 60 students of Tidar University Biology Education. The research instrument used was in the form of questionnaires and validation sheets by the validator. Based on data on Problem Solving skills 38, 3% chose the number 5 meaning that in this Plant Biosystematics e-module all 5 indicators have been fulfilled. Based on the development of the e-module by the validator, the results of the material were 80.5%, the presentation aspect was 54%, the linguistic aspect was 24%, and the graphic aspect was 34%. Based on the data above, the development of the Plant Biosystematics e-module can be used as a learning module that can improve their problem solving skills.

1. INTRODUCTION

Biology Education is one of the departments in the Faculty of Teacher Training and Education at Tidar University. Tidar University strongly supports learning using blended learning, it is proven that the existing facilities and infrastructure at Tidar University are very supportive of learning using blended learning. ELITA is a forum for Tidar University lecturers to do blended learning. Through ELITA, lecturers and students can maximize the learning process. One of the challenges of universities in the era of the industrial revolution 4.0 is developing technology literacy skills, with the existence of ELITA having accommodated lecturers and students in learning. The use of ELITA at Tidar University has not been fully carried out in learning. Lecturers use ELITA only four times during one semester, two times before the midterm exam and two times after the midterm exam. To maximize ELITA, lecturers need e-modules to support their learning.

Plant Biosystematics is one of the courses in the Biology Education Study Program which is taken by third semester students. The Plant Biosystematics course does not have either print or electronic modules. Therefore, to support learning in the Plant Biosystematics course e-module is needed. E-module is a development of a print module in digital form which adopts a lot from the print module. According to Suarsana and Mahayukti (2013) in Sugihartini (2017) the advantages of e-modules compared to print modules are that they are interactive in nature, facilitate navigation, allow display or load images, audio, video, and animation, and are equipped with formative tests/quizzes that allow automatic feedback immediately. Another advantage of e-modules in the learning process lies in the problem-based learning stage, namely the orientation of lecture participants to problems, organizing lecture participants to learn, guiding individual and group investigations, developing and presenting work, and analyzing and evaluating the problem-solving process.

Problem Solving is a skill that can be developed through e-modules in the Plant Biosystematics course. Based on the results of the research that has been done, problem solving skills can be carried out in several steps, 1) understanding the problem, 2) presenting the problem, 3) planning problem solving strategies, 4) executing plans, and 5) evaluating and expanding the solution (Warimun, 2012). Problem solving is a provision for students to live the process of life, wherein life there are various problems faced and should be interpreted positively. The existence of a given problem will encourage students to be more active in learning, challenge students' thinking skills to overcome the problems they face, find the right solution (solving) to these problems (Ristiasari, 2012). Based on the background that has been disclosed, to support learning in the Plant Biosystematics Education Study Program, it is necessary to develop a Problem Solving-Based Plant Biosystematics e-module.

Based on the background of the problem above, the formulation of the problem of this research is as follows: 1) What are the stages of the development of the e-module in Plant Biosystematics lectures with the 4-D model (four D model), and 2) How is the effectiveness of the resulting Plant Biosystematics e-module in improving problem-solving skills among students of the Biology Education Department Tidar University.

According to Vembriato in Fausih (2015) states that a module is a teaching package that contains a concept unit from teaching materials. Module teaching is an effort to organize individual learning that allows students to master a unit of the subject matter before they move on to the next unit. Module is the smallest unit of teaching and learning programs, in which students learn individually or are taught by students to themselves (self-instructional). Modules are a kind of planned learning activity, designed to help students' complete certain goals. Modules are a kind of program package for learning purposes, said Goldschimid. A module is a unit of teaching programs arranged in a specific form for learning purposes and to help individual students achieve certain goals. The module is a complete measuring tool and is a unit that can be used as a unit from all other units.

Dede (2014), e-modules are learning materials that are systematically designed based on a certain curriculum and are packaged in a specific time unit, which is displayed using electronic devices such as computers or androids. Dimhad (2014), e-module is part of electronic-based e-learning, where learning utilizes information and communication technology, especially electronic devices. This means not only the internet but all electronic devices such as films, videotapes, OHPs, slides, LCD projectors, tape sets. E-module is a learning tool or tool that contains materials, methods, limitations, and ways of evaluating which are designed systematically and attractively to achieve the expected competencies according to the level of complexity electronically (part of e-learning).

As a learning media used by students to solve learning problems, a module must-have characteristic. These characteristics were adopted from the print module media, this was done because the characteristics of the print module were still relevant when applied to e-modules. Anwar (2010) in Nawawi (2017) states that the characteristics of the module are as follows: a) Self-instructional (students are able to teach themselves, not depending on other parties). The point is that students are considered to be independent in learning lessons by obtaining minimal assistance from the teacher, b) Self-contained (all learning material from one unit of competence is learned is contained in one intact module). The point is that the content in the module contains all material (there are materials, worksheets, evaluation) of one competency that students must learn, c) Standalone (the module developed does not depend on other media or does not have to be used together with other media). The point is that in the use of modules, they can be used alone as complete media without using other media as a complement, d) Adaptive (modules should have high adaptive power to the development of science and technology). The point is that the module is adapted to the characteristics of students, e) User-friendly (the module should meet the rules of being familiar/friendly to the user), f) Consistency (consistent use of spaced fonts and layout). The point is in the writing of letters, the use of spaces, and the layout arrangements must be equal and balanced with each other. The characteristics of the module above are the characteristics of the print module, but the details of these characteristics can be applied in the e-module.

From some of the theory and opinions above, it can be concluded that basically, an e-module has characteristics that can be learned anywhere, and anytime by students, students do not depend on others (self-instructional), e-modules provide opportunities for students to be active in the process of teaching and learning activities.

Problem solving skills are a person's basic ability to solve a problem that involves critical, logical, and systematic thinking. Kaya, et al. (2014) stated that problem solving skills are basic skills that a person must possess and can be used in various areas of everyday life. Memnun, et al. (2012) also argued that enabling individuals to acquire problem-solving skills and training individuals who could solve problems encountered during their real-life were priority goals and the main goal of education today. This shows that problem-solving skills have an important role in education. According to Polya (Hamiyah and Jauhar, 2011), problem-solving skills contain four indicators, namely 1) understanding the

problem, 2) planning solutions, 3) solving problems according to plan, and 4) checking all steps again.

Problem-solving is generally considered to be the most important cognitive activity in everyday and professional contexts. However, learning to solve problems requires setting the level of formal education because of a limited understanding of the process (Nayazik, 2017). To train student creativity, activities are needed that provide opportunities for students to use their thinking power, develop ideas, find solutions to problems so that they can develop problem-solving skills properly, an appropriate learning model is needed.

Bransford & Stein (1993) introduced IDEAL Problem Solving as a learning model that can help to solve problems. IDEAL Problem Solving can be used to solve problems with well-defined problems/problems. The steps in learning the IDEAL Problem-Solving model are (1) identifying problems, (2) defining objectives, (3) exploring solutions, (4) implementing strategies, and (5) reviewing and evaluating the impact of the influence.

In solving the problems through learning, the learner will get some higher rules or complex rules. The problem-solving activities itself require the learner to re-call some simple rules and they have learned before. However, to master those simpler rules, the learner must master some concrete concepts first. Then, to learn the concepts, the learner must learn some discriminations or differentiations first. It appears that Gagne's problem-solving is the most complex intellectual skill in the ability to solve new problems by accommodating the existing rules. The intellectual skill itself is one of the five types of learning that he has proposed. The significance of problem-solving learning outcomes also can be seen from the 'position' in learning design. For example, Hokanson & Hooper (2004) proposed a taxonomy for instructional design, which includes five learning levels.

2. RESEARCH METHODS

The stages of the study are research and development (R & D). R & D model used for the basis of product development is an adaptation of the Four-D model development research proposed by Thiagaraj an (1974:5). The aim of developing this product is to generate a Plant Biosystematics e-module, which is suitable to use for students from the Biology Education program. This model consists of 4 stages of development: Define, Design, Develop and Disseminate. 1) Define (defining stages) aims to set and define the requirements in making the Plant Biosystematics e-module. In defining stages, the researcher is divided into 3 components: input, process, and output. The input component includes (a) determining the general objectives and b) user needs. The process components include examining the relationship between every component. Then the last component is the research output component in formulating the specific goals. 2) Design (designing step). This step is the design results of the defining stage, which is divided into 3 components. The first is input components, including a) a particular objectives formula, and b) the writing method of the Plant Biosystematics e-module. The second component of the process is that the researcher arranges the Plant Biosystematics e-module design. Then, the output component includes one Plant Biosystematics e-module design and one validation script design. 3) Disseminate (disseminating stage), the stage is the dissemination of the Plant Biosystematics e-module. The researcher conducted the dissemination to the Biology Education students in the Faculty of Teacher Training and Education at Tidar University.

This study is development research with a 4-D model implemented with the experimental method. In the experimental class, the learning process is given treatment with Group Investigation (GI) learning method using the Plant Biosystematics e-module. The data collection technique uses an observation method, documentation, interview, questionnaire, and test.

This study uses True Experimental Design with the research technique of Posttest-Only Control Group Design. In this design, there are two groups chosen randomly, the first groups are given treatment (X), and the other groups are not. The groups given treatment are called experimental groups, and the groups that are not are called the control group. Both groups are then asked to fill out the questionnaires to see an increase and decrease in students learning motivation.

The data processing techniques are differentiated in problem-solving skills and development data of the Plant Biosystematics e-module. First, the data on problem-solving skills, the data analysis on problem-solving skills, uses descriptive analysis. The data obtained is the pre-test and post-test value. The pre-test and post-test value analysis before and after using the Plant Biosystematics e-module is the gain score analysis. The analysis of gain score value is normalized from pre-test and post-test score based on the following formula:

$$< g >= \frac{\%\,(g)}{\%\,(g)_{max}}$$

$$< g >= \frac{(\% < S_f > - \% < S_i >)}{(\% < S_m > - \% < S_i >)}$$

From both formulas above, the <g> symbol indicates the normalized gain score. Sf symbol indicates the post-test mean score. Then, the Si symbol indicates a pre-test mean score. Sm symbol indicates the maximum score.

The normalized gain score <g> is deemed suitable for analyzing the students' pre-test and post-

test results. The normalized gain score <g> is also the better indicator in showing the treatment effectiveness level from the score or post-test (Hake, 1998). The level of normalized gain score <g> is categorized into three categories as can be seen in Table 1.

Table 1. Gain Score Criteria

No	Gain Score	Criteria
1	0,00 < g < 0,30	Low
2	0,30 ≤ g < 0,70	Average
3	0,70 ≤ g < 1,00	High

The assessment component of the Plant Biosystematics e-module consists of four aspects. The material component consists of five assessment indicators. The language component consists of two assessment indicators. The serving component consists of four assessment indicators. The graphic component consists of four assessment indicators. The score conversion becomes 5 scales for every component in the Plant Biosystematics e-module product, as shown in the following table:

Table 2. Score Conversion of Plant Biosystematics E-module Assessment

No	Component	Interval Score	Category
1.	Content Eligibility	X > 20	Very good
		16,67 < X ≤ 20	Good
		13,33 < X ≤ 16,67	Bad
		X ≤ 10	Poor
2.	Presentation	X > 16	Very good
		13,33 < X ≤ 16	Good
		10,67 < X ≤ 13,33	Okay
		8 < X ≤ 10,67	Bad
		X ≤ 8	Poor
3.	Language	X > 8	Very good
		6,67 < X ≤ 8	Good
		5,33 < X ≤ 6,67	Okay
		4 < X ≤ 5,33	Bad
		X ≤ 4	Poor
4.	Graphic	X > 16	Very good
		13,33 < X ≤ 16	Good
		10.67 < X ≤ 13,33	Okay
		8 < X ≤ 10,67	Bad
		X ≤ 8	Poor

3. RESULTS AND DISCUSSION

Based on data on problem-solving skills involving 60 students who are the research objects, the following data are obtained.

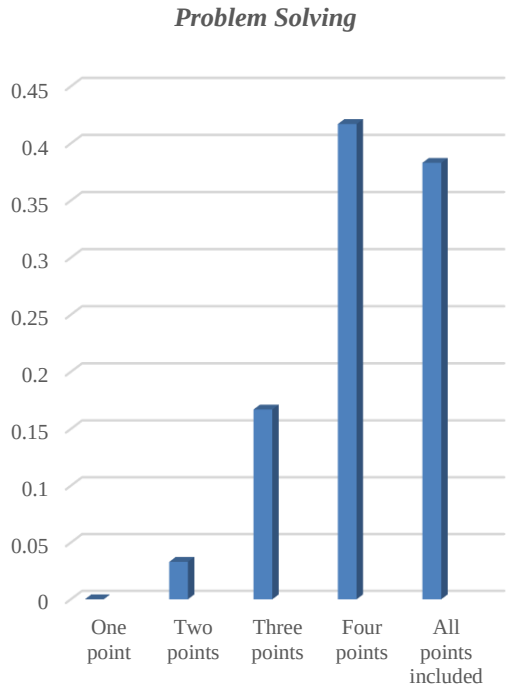

Figure 1. Data Results of Problem-Solving Skills (Problem-Solving)

The data is obtained from filling the Google Form by paying attention to the problem-solving instruments. The instruments consist of 5 points, including:

(1). Choosing number 5 if all 5 indicators fulfilled, the 5 indicators consist of:
   a) Increase the students' knowledge in solving the problem,
   b) Students can formulate the problem from the problems presented,
   c) Students can have problem-solving planning,
   d) Students can find solutions to the problems presented,
   e) Students can conclude the problems found.

(2). Choosing number 4 if all 4 indicators fulfilled,
(3). Choosing number 3 if all 3 indicators fulfilled,
(4). Choosing number 2 if all 2 indicators fulfilled,
(5). Choosing number 1 if one of indicators fulfilled.

It can be seen from 60 students, and the research objectives are obtained the data that 3.3% choose number 2, which means in the Plant Biosystematics e-module problem-solving based, the 2 indicators have fulfilled. Then, 16.7% choose number 3, which means in the Plant Biosystematics e-module problem-solving based, the 3 indicators have fulfilled. After that, 41.7% choose number 4, which means in the Plant Biosystematics e-module problem-solving based, the 4 indicators have fulfilled. The last, 38.3% choose number 5, which means in the Plant Biosystematics e-module

problem-solving based, the 5 indicators have fulfilled.

The data for the development of the Plant Biosystematics e-module involve 2 validators: material expert and media development expert. From every validator, it is obtained the mean presented in the following diagram:

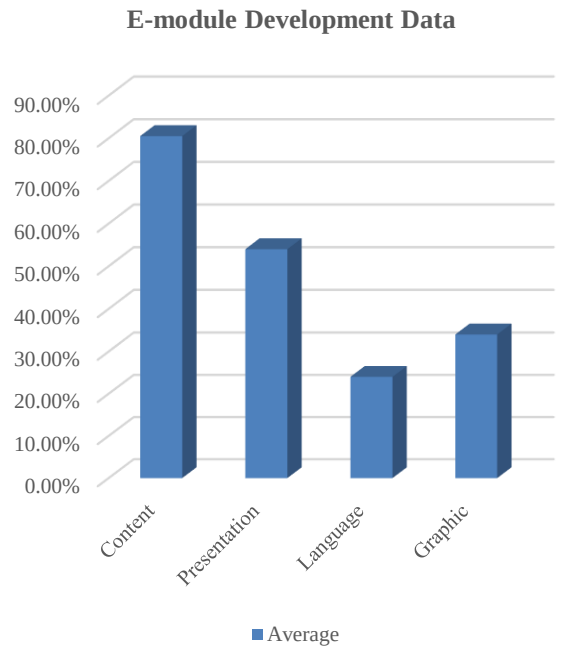

Figure 2. Results of E-Module Development Data

Those 4 indicators from validation results can be seen from the content/material indicators, presentation, language, and graphic in a very good category. It can be seen that the development of the Plant Biosystematics e-module from the content/material of two validators, it is obtained the mean of 80.5% while seen from the presentation aspect of two validators give the average value of 54%. Then, in the language aspect, the two validators give the average value of 24%, and in the graphic aspect, the two validators gave the average value of 34%.

4. CONCLUSIONS AND RECOMMENDATIONS

The study in Development of Plant Biosystematics e-module Problem-Solving Based can be concluded as follows: a) the Development of Plant Biosystematics e-module Problem-Solving Based is developed from Four-D model through Define, Design, Develop, and Disseminate. It is obtained the validation data from the material expert and media development expert. The product of Plant Biosystematics e-module seen from the two validators, both material expert and media expert stated that Plant Biosystematics e-module developed is in the very good category, and (b) Development of Plant Biosystematics e-module Problem-Solving Based is developed through Four-D model stages: Define, Design, Develop, and Disseminate. It is obtained the data on problem-solving skills with 60 students as research objects. The problem-solving skill based on the Plant Biosystematics e-module developed is in a good category and can increase students' problem-solving skills.

The suggestions that can be delivered after the research of Development of Plant Biosystematics e-module Problem-Solving Based are a) Plant Biosystematics E-module is expected can be registered become ISSN book so that it can be the references, not only for students of Tidar University but also other universities b) Material/content aspects, presentation, language, the graphic can be increased so that it can be disseminated.

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