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Development of Alternative Plant Tissue Culture Module to Optimize Science Process Skills and Curiosity in Modern Biotechnology Learning in High School

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Abstract

The ideal modern biotechnology is done by practicum. Practicum of plant tissue culture, especially in vitro germination, is intended to train students to perform aseptic activities according to tissue culture characteristics, but not to obtain substantial culture results. This study aims at test the effectiveness of alternative plant tissue culture techniques as a development of alternative plant tissue culture module to optimize science process skills and curiosity learning in high school. The research method uses the ADDIE instructional model. The data taken are in the form of the effectiveness of tissue culture techniques, module validity by media and material experts, module effectiveness seen from the value of science process skills and curiosity, the practicality of the module seen from the response of users namely teachers and students. The results showed that alternative plant tissue culture techniques were effectively used as practical material on the topic of tissue culture in high school to practice science process skills; the modules developed were considered very valid, effective, and practical; the developed modules had characteristics compiled based on simple research on culture network, equipped with images to clarify the practical process, equipped with observation tables as testing data that can guide students to find the concepts taught Based on these results the module is recommended, the use of modules for practicum must manage the time so that everything is in well condition of learning.

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INTRODUCTION

The ideal learning of modern biotechnology is done by practicum. Practicum is a learning that can help students find facts from the theory they learn so that students have cognitive abilities and psychomotor abilities (Murti et al., 2014). Practicum in learning Biology is an effective method for achieving learning goals that bring out students' scientific attitudes (Rustaman, 2005).

Alternative plant tissue culture techniques can be carried out by students with the use of alternative tools and materials that are easily available around such as coconut water, agar-agar, and fertilizer, the tools used are enkas and pressure cookers. The addition of coconut water to tissue culture media has an effect on plantlet growth. The treatment of coconut water concentration level of 100 ml/l is in addition to producing good shoot growth, also produced the highest number of roots, and high plantlet growth (Tuhuteru et al., 2012).

The application of learning modules can condition learning activities in better and well planned, and students can do learning activities whenever and wherever, with or without teacher guidance (Fitriyati et al., 2015). Modules are instructional materials that are arranged systematically with language that is easily understood by students, according to their age and level of knowledge so that they can learn independently with minimal guidance from educators. Modules are implemented and packaged with strategies that make students more active in learning.

Module based learning with scientific methods allows students to acquire knowledge based on systematic steps. Scientific methods can optimize students' science process skills in learning modern biotechnology. This is reinforced by the results of research from Sufinah et al. (2013) on the application of biology practicum modules can improve science process skills. Based on the explanation above, it is necessary to conduct research on the development of a simple tissue culture module to optimize science process skills and curiosity in the learning of modern biotechnology materials in high school class XII.

METHODS

This study consists of two stages, namely plant tissue culture research study and module development research. Research study consists of four sub-studies, each using a single-factor, and completely randomized design (CRD). In this sub-study there were 3 or 2 treatment levels and 5 repetitions at each treatment level. The method used in development research is the Research and Development method (R & D).

Table 1. Data Collection Instruments and Techniques

No.	Data	Engineering collection	Data	Instrument	Data source
	Germination acceleration	Observation		Observation sheet	Green bean seeds
	Module validity	Questionnaire		Expert material questionnaire and media experts	Teachers and lecturers
	Module effectiveness Measuring PPP and curiosity	Observations, and questionnaires		KPS observation sheet, and curiosity questionnaire sheet	lecturers
	Practicality of modules	Questionnaire		Questionnaire sheet	Teachers and lecturers
	Module characteristics	Observation		Observation sheet	Researcher

The research design in this study includes 5 stages (Aldoobie, 2015). This research is a research and development that refers to ADDIE instructional model. This model was chosen because of its simple nature (basic stages of development) and systematically structured,

making it easy to understand, with stages of analysis, design, development, implementation and evaluation. The five stages are interrelated and systematically structured (Aldoobie, 2015). Data analysis on module development using percentages. Data on module development are of two types, namely qualitative data in the form of suggestions and inputs and quantitative data scores from questionnaires. Data collection techniques used are in Table 1.

RESULTS AND DISCUSSION

The research data consist of data from alternative plant tissue culture research results and the research results on module development in high school.

Effectiveness of plant tissue culture techniques for plant propagation

Based on the data from the results of research conducted at the UNNES Network Culture Laboratory, in the I-III sub-study one way ANOVA was conducted. The results of the one way ANOVA test in sub-research I were the effect of coconut water concentration on the total hypocotyl-epicotyl length and the number of significant roots with a significance probability value of 0,000. This shows that there is a significant effect of coconut water concentration on the hypocotyl-epicotyl length and the number of roots of mung bean seeds.

The different influence between the concentration of coconut water on the hypocotyl-epicotyl length and the number of roots of mung bean seeds, was further tested using the BNT Test whose results in Table 2 are as follows.

Table 2. BNT Test Results Sub Research I

Concentration of coconut water (ml/l)	Average hypocotyl and epicotile length	Average number of roots
0	4.58^{a}	2.80^{c}
50	3.18^{b}	4.00^{b}
75	2.48^{c}	2.80^{c}
100	1.88^{d}	6.00^{a}

The results of the LSD test in Sub-research I concluded that the concentration of coconut water 0 ml / 1 caused the longest hypocotyl-epicotyl compared to other treatments. The results on the study of root number parameters showed that the concentration of coconut water 100 ml / 1 resulted in the highest number of roots (Table 2). The results of the one way ANOVA test in sub-research II were the treatment of fertilizer concentration on the hypocotyl-epicotyl length and the number of significant roots with a significance probability value of 0,000. This result shows that fertilizer concentration has a significant effect on the hypocotyl-epicotyl length and number of roots. To find out the most optimal fertilizer concentration, BNT test is carried out, the results in Table 3 are as follows.

Table 3. Results of BNT test Sub Research II

Fertilizer concentration (gr/l)	Average hypocotyl and epicotile length	Average number of roots
1	2.58^{b}	2.60^{b}
2	2.90^{a}	4.60^{a}
3	2.38^{c}	1.20^{c}

The results of the LSD test in Sub-research II found that the concentration of 2 g / 1 fertilizer resulted in the longest hypocotyl-epicotyl length compared to other doses. The results of the study on root number parameters showed that the concentration of fertilizer 2 g / 1 resulted in the highest number of roots (Table 3).

The results of the one way ANOVA test in sub-study III were the treatment of agar concentration on the hypocotyl-epicotyl length and the number of significant roots with a significance probability value of 0,000. These results indicate agar concentration has a significant effect on the hypocotyl-epicotyl length and number of roots. To find out the concentration of agar the most optimal is carried

out BNT test, the results in Table 4 are as follows.

Table 4. Results of BNT test Sub Research III

Gelatin concentration (gr/l)	Average hypocotyl and epicotile length	Average number of roots
6	2.54[c]	0.80[c]
8	3.32[a]	4.60[a]
10	2.82[b]	2.00[b]

The results of the LSD test in Sub-research III found that the concentration of 8 g / 1 agar resulted in the longest hypocotyl-epicotyl length compared to other doses. The results of the study on root number parameters showed that the concentration of fertilizer 8 gr / 1 resulted in the highest number of roots (Table 4.3). Furthermore, in Sub-research IV using the t-test. The sub-research IV data, namely the lighting treatment (dark and light) on the hypocotyl-epicotyl length and the number of roots was carried out by the t-test. The test results show a significance value of 0,000. This means that there is an influence of hypocotyl-epicotyl length and the number of roots between dark and light treatments. Both hypocotyl-epicotyl growth and the number of roots in bright conditions are better than dark conditions.

Module validity

The assessment was given by two material experts with a mean percentage of 93.75% with very valid criteria. This value was obtained from two media experts. There are two aspects of the material expert module evaluation, namely the content and presentation aspects, both of which have very valid criteria. The material presented in the module is additional material that can provide more information that students do not find in the textbook. Practicum on alternative tissue culture can provide an effect on improving students' science process skills.

Module effectiveness

The following is a percentage of the value of science process skills and curiosity in Figure 1.

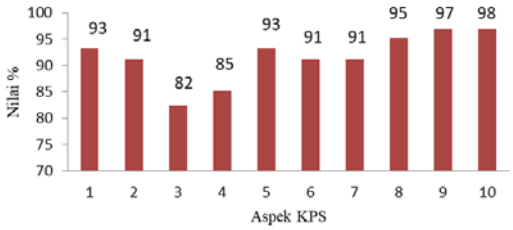

Figure 1. Percentage Value of Aspects of Science Process Skills in Biotechnology Learning Using Modules

Remarks: 1 = observing, 2 = grouping, 3 = interpreting, 4 = predicting, 5 = asking questions, 6 = hypothesizing, 7 = planning experiments, 8 = using tools / materials, 9 = applying concepts, 10 = communicating.

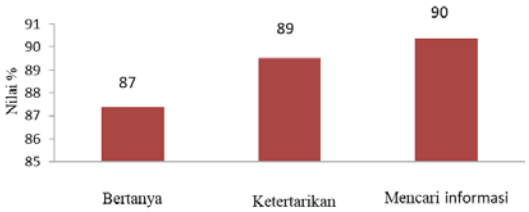

Figure 2. Percentage Value of Curiosity Aspects in Biotechnology Learning Using Modules.

Based on the percentage value of science process skills with the use of alternative plant tissue culture modules obtained high scores. This is consistent with the study by Maskhuliah et al. (2017) learning using modules can improve students' science process skills. The use of modules in learning can improve student science process skills and curiosity. In accordance with the results of observations of alternative plant tissue culture practicum obtained the high value of science process skills and curiosity.

Practicality of modules

Practicality of the module is assessed from the user's response, namely the teacher and students. The chosen teacher to respond to the

developed module was a Biology teacher who was active teaching at SMAN 2 Mranggen and had experience in teaching, and was willing to be a teacher and gave a response to the evaluation of module practicality. In addition, user responses were also obtained from 10 students of class XII of SMAN 2 Mranggen. The results of the practicality percentage of students were 96.25%, while the practicality assessed by the teacher was 91.5% with very practical criteria. Yulia et al. (2017) states that the instructional material made must have a language that is in accordance with the material and the language used must be communicative so that the reader is easy to understand. The module developed based on the results of qualitative data is easy to understand, uses communicative language, interesting with pictures, students feel happy learning to use modules.

Module Characteristics

The characteristics of developedmodule were obtained from the results of the preliminary study. The characteristics ofdevelopedmodules are as follows:

1) Compiled based on simple research on tissue culture. This research was developed to train students' skills in working aseptically.
2) Equipped with pictures to clarify the practical process.
3) Equipped with an observation table as a test of data that can guide students to find the concept which is being taught.

The research-based module of alternative plant tissue culture techniques contains many images to clarify the student's practical process. Modules can be used to train students' skills in working aseptically. The material presented in the previous module has been validated by material experts and the media to get the right thing and in accordance with the objectives of the acquisition achieved. The suitability of the material must support students in learning because material is the most important thing (Setiowati et al., 2017). In order to avoid misconception students must understand the limits and reach of the material so that the objectives can be achieved. Material validity and material truth are suitable concepts and facts so that students' misconceptions are not formed (Rizqiyah et al., 2018).

Material validity includes content sequence, material coverage in accordance with the compiled learning plan . The material presentation that is logical and easily digested by students is one of the supporting forces so that material is easily conveyed to students well (Sari et al., 2016). Material validity will also increase students' curiosity and can be a bridge for students to be able to deepen more the material. So that the material taught will become longer embedded in students' thinking (Muliyati et al., 2017).

Practicality of the module in terms of its use must be practical, namely in the use of modules must be in accordance with the curriculum that applies in schools. Modules that have levels that are appropriate for students, the time of both creation and use that are relevant, the level of difficulty that is appropriate to students' abilities (Fadilahet al., 2016). The use of modules is effective for class XII students to improve student science process skills and student curiosity.

KPS and curiosity can be seen from the use of simple tissue culture modules in doing practicum. The practicum can measure KPS and curisity through numbers. Because in the module there are images that provoke students' curiosity more deeply and a practical practicum process can train students in skills. Practical material can train students in the ability of KPS because by direct practice the material and concepts will be clearer and remembered in the long term (Komang et al., 2017).

CONCLUSION

Based on the results of the research and discussion that have been put forward, it can be concluded alternative plant tissue culture techniques are effectively used as practical material on the topic of tissue culture in high school to practice science process skills.

Developed modules are considered effective as teaching materials based on their effects on the value of science and curiosity process skills which are high. Developed modules are considered very practical as teaching materials based on the percentage of both student responses and teacher responses. Developed modules have characteristics and are compiled based on simple research on tissue culture; this study was developed to train students' skills in working aseptic, equipped with images to clarify the practical process, equipped with observation tables as testing data that can guide students to find concepts which are taught.

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