

Analysis of Research-Based Teaching Material Requirements on Bio-Growth Topic in Prospective Biology Teachers

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ABSTRACT

Plant physiology is a compulsory subject in the Department of Biology Education, there are three topics to focus on, namely biophysics, biochemistry, and bio-growth. To understand the concepts contained in each topic, especially on the topic of bio-growth, higher-order thinking skills are needed to be able to relate each concept to real life. One of the efforts to improve students' understanding of concepts is with the right teaching materials. Therefore, this study aims to identify and analyze student needs for research-based teaching materials. The research instruments used were observation sheets, questionnaire sheets, and interview guidelines. The research subjects are students majoring in biology education in semester 5 who are taking plant physiology courses. The results showed that more than 75% of students felt the need for different teaching materials, namely research-based teaching materials. With research based teaching materials, learning resources become more contextual and applicable, thus it is hoped that students' understanding of plant physiology will be formed optimally.

Keywords: bio-growth, plant physiology, research-based teaching materials

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INTRODUCTION

The plant physiology course is a compulsory subject in the Department of Biology Education. Three topics that are important and studied in the plant physiology course are the topic of bio-growth, the topic of biochemistry, and the topic of biophysics. One of the topics of plant physiology that need to be mastered and interested by students are about bio-growth. The topic of bio-growth studies the concepts of growth and development in plants, this topic requires special thinking skills to be able to understand it. The need for thinking skills that must be possessed is related to the concept of bio-growth which not only has to be memorized but needs a deeper understanding so that students know how to apply it to the real world.

In general, students still have difficulty in mastering concepts in plant physiology, some students do not understand the basic principles of science such as metabolic processes, namely photosynthesis and cellular respiration (Lynd-Balta et al., 2006; Wilson et al., 2006). Nuha et al.'s (2016) research found that students' understanding of biology concepts was still very lacking, especially the concepts of molecular biology. Research by Gloria et al. (2017) concluded that the average student understanding of plant physiology is still in the moderate category, so efforts are still needed to improve it.

Efforts to improve understanding of concepts in students have been carried out, one of which is by providing teaching materials, be it books, modules, or other forms of teaching materials. Textbooks are books that contain a scientific analysis of the results of the curriculum in written form (National, 2008).

Nurdyansyah et al. (2018) conclude that textbooks can improve understanding, for example, magazine-based textbooks. Another research is learning with teaching materials in the form of modules developed using the CPS method, effective and practical to use in learning (Rahmatin et al., 2019).

One of the teaching materials that can be an alternative in solving problems related to students' lack of understanding is research-based teaching materials. Several studies have proven the advantages of research-based teaching materials, including research-based teaching materials that really help lectures (Fitriyati et al., 2015; Oktaviana et al., 2015). Research-based teaching materials are effective in improving student learning outcomes (Wulandari et al., 2017). Research-based textbooks can broaden and deepen the material in an applicative manner (Primiani, 2018).

Research-based teaching is identical to research-based learning. Research-based learning is a constructivist and contextual learning. Research-based learning encourages activities with a "learning by doing" approach (Widayati, 2010), while the application of a research-

Table 1. Plant physiology courses' scores in five years

| No. | Academic year | Score |
|---------|---------------|-------|
| 1. | 2014-2015 | 67.10 |
| 2. | 2015-2016 | 53.71 |
| 3. | 2016-2017 | 54.60 |
| 4. | 2017-2018 | 73.66 |
| 5. | 2018-2019 | 52.84 |
| Average | | 60.38 |

based curriculum has led to a strengthening of the quality of learning that can trigger student involvement.

Given the importance of efforts to improve various thinking skills needed by students, one of the efforts is to make research-based teaching materials on the topic of bio-growth for the plant physiology course. Therefore, there is a need for a needs analysis of research-based teaching materials. This study aims to analyze student needs for research-based teaching materials on the topic of bio-growth.

METHODOLOGY

Research Design

This research is an analytical research to obtain information related to student needs regarding teaching materials. The research method uses a qualitative descriptive method. The needs analysis stage refers to the analyze stage in the ADDIE development model (Branch, 2009).

Sample and Data Collection

The research instrument used in the form of observation sheets, questionnaire sheets, and interview guidelines. The research subjects are students majoring in biology education in semester 5 who are taking plant physiology courses at one of the public universities in the city of Cirebon, West Java. The time of the research is from July to December 2019.

Analyzing of Data

The analysis stage includes five stages, as follows:

1. validating the imbalance of real conditions with ideal conditions (validate the performance gap),
2. determine the learning objectives (determine instructional goals),
3. confirm the target product (confirm the intended audience),
4. identify the things needed in development (identify required resources), and
5. determine the system potential delivery (determine potential delivery systems).

FINDINGS/RESULTS

The discussion below is based on the five stages of research.

Validating the Imbalance of Real Conditions with Ideal Conditions (Validate the Performance Gap)

To find out the imbalance of real conditions with ideal conditions, namely by analyzing the learning outcomes of the plant physiology course. The analysis was carried out on the final exam scores for the plant physiology course for the last five years.

Table 2. Student's n-gain criteria for each understanding indicator

| n-gain | Low (%) | Medium (%) | High (%) |
|----------------|---------|------------|----------|
| Explaining | 35 | 45 | 19 |
| Interpreting | 16 | 61 | 23 |
| Application | 19 | 55 | 26 |
| Perspective | 39 | 52 | 10 |
| Empathy | 81 | 13 | 6 |
| Self-knowledge | 19 | 42 | 39 |

Table 1 shows the results of the analysis of plant physiology values in the last five years. The results of the analysis show that the average value of plant physiology courses for the last five years is 60.38, this meets the quality score standard for the C+ category, meaning that the achievement of plant physiology course scores is still very low when referring to the standard of success scores for plant physiology, which is at least one must achieve B+ quality score, or 75 to 80.

Determine the Learning Objectives (Determine Instructional Goals)

The learning objective of the plant physiology course is that students have an ideal understanding, according to the category of Wiggins and McTighe (2012). The data obtained from the research instrument, namely plant physiology questions based on understanding indicators, showed that as many as 77% of students had n-gain understanding which was included in the medium criteria, and very few students had n-gain understanding which was included in the high criteria (7%), this means that plant physiology learning has not been able to improve student understanding in accordance with ideal expectations. To be clearer on how students understand, an analysis of the value of student understanding is carried out on each indicator. The results of the analysis are presented in **Table 2**.

The results of the analysis of student understanding per indicator, namely explaining, interpretation, application, perspective, empathy and self-knowledge, obtained the highest student understanding value, namely for understanding self-knowledge, namely 42% including medium criteria and 39% including high criteria. The value of understanding empathy is included in the very low category because as many as 81% of students belong to the low criteria, only 6% are included in the high category.

The highest average score was obtained for the application understanding indicator (47), this is because the plant physiology course has lecture programs in the form of practicum and mini research assignments. Practicum in the plant physiology course is eight practical sessions for eight effective weeks, training skills to apply the knowledge that has been obtained in theoretical lectures.

The ability to explain has the second highest average score, this is because in the plant physiology course there are learning activities in the form of discussions and presentations. Discussion and presentation activities can train students in explaining skills, especially explaining the content of the plant physiology course.

For the smallest average value, which is obtained on the empathy understanding indicator (10), this shows the lack of a learning process in plant physiology lectures that trains that understanding. The assignments given have not yet touched the realm of student empathy, in addition, the material in the plant physiology course emphasizes mastery of content. The same thing applies to the understanding of self-knowledge (22), understanding of self-knowledge is not trained in plant physiology lectures. Based on three plant physiology topics, almost all

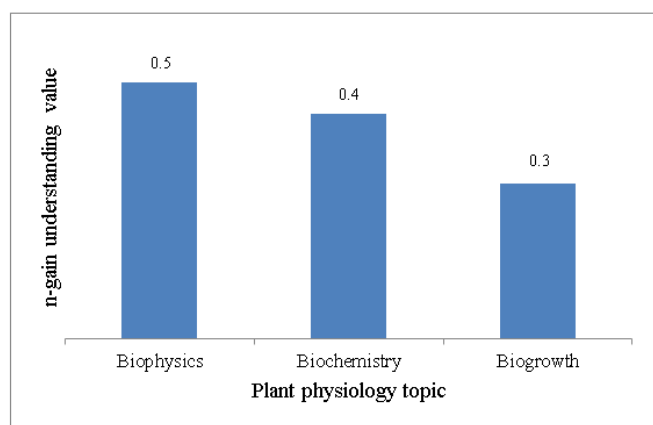


Figure 1. n-gain understanding scores for each plant physiology topic

of them prioritize content understanding including training on understanding explaining, interpreting, perspective, and application.

Plant physiology topics each play a role in forming understanding, more details on the results of the understanding formed can be seen by knowing the n-gain of each plant physiology topic, this is presented in **Figure 1**.

For the value of n-gain on understanding per plant physiology topic, the topic of biophysics has the highest n-gain value (0.5), which is included in the medium criteria. The topic of biophysics is a topic that is of great interest to students and has interesting material to discuss regarding the relationship between plants and water.

Comparison of n-gain on the three plant physiology topics shows that the topic of bio-growth has the lowest n-gain value (0.3), which is included in the low criteria. The topic of bio-growth has content that is easy but less attractive to students, and less interesting, so we need a new way that can increase student interest so that n-gain can be improved.

Confirm the Target Product (Confirm the Intended Audience)

To find ways that can improve student understanding, first it must be known how students are interested in plant physiology courses.

The results of the study found that students considered plant physiology courses to be difficult subjects, so they needed more optimal learning resources. As many as 90% of students stated that they needed other learning resources other than the usual textbooks. Students who take plant physiology courses need varied learning resources, students think that varied sources of teaching materials will attract them more.

From the results of student questionnaire searches, as many as 75% of students have never seen and know research-based teaching materials, this explains that research-based teaching materials can be alternative teaching materials that students can use to improve understanding. Almost all students agree with the research-based plant physiology teaching materials. Students think that research-based teaching materials are new to them, therefore students feel interested in these teaching materials.

Identify the Things Needed in Development (Identify Required Resources)

Students' opinions regarding research-based plant physiology teaching materials

The need for research-based plant physiology teaching materials can be determined by how students think about these teaching

materials. The results showed that 75% of the students were interested in the plant physiology course, and 90% of the students considered the course important to be studied. This means that the plant physiology course is very important to pay attention to. In order for lectures to run more optimally, it is necessary to provide different teaching materials, 93% of students need special teaching materials for plant physiology courses.

Research-based teaching materials were approved by the majority of students (79%), students agreed if researches related to plant physiology were used as teaching materials. With research-based teaching materials, learning resources become more contextual and applicable, thus it is hoped that students' understanding of plant physiology will be formed optimally.

A good textbook can meet several criteria including case examples, picture illustrations, and examples of questions and solutions, integration of character education in the concept of theoretical descriptions, realistic facts and aphorisms in textbooks that can improve good character (Situmorang, 2010). In this regard, the survey results show that as many as 76% of students choose the type of essay question. Therefore, the type of question that will be included in the teaching materials is the type of description question.

Widodo in Lestari (2013) explains that to produce teaching materials that are able to play their functions and roles in effective learning, teaching materials need to be designed and developed by following the rules and elements that require them.

The elements that must be met in the preparation of teaching materials include consistency, format, organization, and appearance. The first is the element of consistency, what is meant by consistency is that the process of preparing teaching materials must pay attention to consistency in terms of the use of fonts, spacing, and layout.

The second is the format element, meaning that the presentation in teaching materials needs to pay attention to single or multi-column formats, vertical or horizontal paper formats, and easy-to-capture icons. The third is the organizational element, which explains that the learning materials must be well organized, in other words that the learning materials contained in the teaching materials must be arranged systematically.

The fourth elements of appearance, namely in a teaching material, are the first points that determine the attractiveness of students. Widodo in Lestari (2013) said that the attractiveness of students to teaching materials in general is more than cover section. Therefore, the cover section is recommended to display images, color combinations, and matching font sizes. In addition, teaching materials can also be given attractively packaged assignments and exercises so that students do not feel bored.

Given the importance of the facial component or the cover of a teaching material, the questionnaire aimed at students also includes several indicators that make up the cover. Some of these indicators include the format of the image for the cover, the location of the image on the cover, the number of images on the cover, the type of font used in the cover, the location of the title on the cover and the colors that are suitable for use in the cover of teaching materials.

The first indicator that will be discussed is the appropriate color for the cover of teaching materials. The results of the survey on students showed that there were no students who agreed that the covers for plant physiology teaching materials were illustrated but in black and white,

on the contrary, 76% of students agreed that the covers for plant physiology teaching materials were illustrated and colorful.

The colors that respondents want related to the colors on the covers of plant physiology teaching materials are soft colors. This is evidenced by the percentage of respondents' partiality to the soft color answer options. The option was chosen by as many as 72% of students as the color for the front cover of plant physiology teaching materials.

The next indicator is the type of image provided on the cover of teaching materials. As many as 48% of students agree that animated pictures/cartoons are the most suitable for the cover of plant physiology teaching materials. This animated image, according to a student survey, should at least be placed under the title with an adjusted size. This option is supported by 72% of students who take plant physiology courses.

Through the survey, it was concluded that the image desired by students was an animated/cartoon image and the image should be placed under the title with the appropriate size. Next, a question is asked to find out how many images are placed. The results showed that as many as 45% of students who took the plant physiology course stated that the number of illustrations placed in front of the teaching materials was more than two.

Regarding the image size criteria, as many as 97% of students want a medium-sized image to be placed on the cover of the textbook. This complements the image size criteria which previously only said that the size was adjusted. Furthermore, for the title on the cover of teaching materials, as many as 59% of students said that the comic sans typeface was the letter that students agreed to for the title of plant physiology teaching materials.

So, the criteria for the cover of research-based teaching materials for the plant physiology course can be concluded that, the cover of the teaching material is composed of a title with comic sans font, provided more than two animated/cartoon images of medium size and the image is placed under the title, the color used for the cover are soft colors. This is in line with the opinion of 76% of student respondents who stated that the cover of teaching materials must be illustrated and colorful.

Research activities are divided into two types. The first variety is a situation where students are directed to use the relevant research achievements of the teacher as part of the teaching materials. At a higher level, there can also be circumstances where a student takes on a role and is involved in his teacher's research activities. The second variety is the development of teaching and learning activities where the process or stages of research are designed to be part or strategies in inquiry.

The research that will be included in research-based teaching materials is previous research that has been carried out by students as well as research related to certain topics in the topic of bio-growth. So, the research activity in question is a research activity in which students are directed to use the relevant research achievements of the teacher. The research report will be developed in a certain format and will be structured in such a way according to the systematics in research-based teaching materials.

The research component consists of: background, procedures, implementation, research results and discussion and publication of research results. All of these provide an important meaning that can be seen from several perspectives: problem formulation, problem solving,

and communicating the benefits of research results. This is believed to be able to improve the quality of learning (Roach et al., 2001).

In line with the opinion, Roach et al. (2001) report on research results that will be included in research-based teaching materials are composed of background, procedures, implementation, research results and discussion. All of these components support each other in shaping student understanding. This is in accordance with the learning objectives of the plant physiology course, namely that students have an ideal understanding, in this case the understanding that will be formed is an understanding that uses understanding indicators according to categories (Wiggins & McTighe, 2012).

Research carried out by students has many advantages. Besides being able to increase the level of students' understanding of a material, the implementation of research also plays a role in the implementation of higher education dharma. Hunaiti et al. (2010) stated that collaboration between research and learning has become the key to success in many world class universities, to produce professional graduates who are ready to carry out cutting-edge research and develop themselves in various disciplines.

Sarwono (2009) explained about the advantages of conducting research conducted by students. According to him, the focus of research is a step that must be immediately carried out by higher education institutions. This step was taken not only to carry out the dharma, but in an effort to increase the competency level of graduates.

A research-oriented university will become a strong and high-quality university, and not only as a university that produces certificates and low-quality graduates. In the future, entering the era of industrialization and modernization, universities will participate as centers of research and development of science and technology.

Lecturer's opinions regarding research-based plant physiology teaching materials

Needs analysis regarding research-based teaching materials, in addition to requiring opinions from students, also requires lecturers' opinions related to biology courses. The results of the study were from the opinions of three lecturers as participants who represented other lecturers in the biology family. The three lecturers argued that the solution when they saw the activity, motivation, and low interest of students in attending lectures, was to provide innovation in discussion materials or by providing more varied learning strategies and methods. Research-based teaching materials to be developed are an innovation that is expected to be part of teaching materials that can arouse students' enthusiasm for learning and curiosity.

Based on the lecturer's response, it is known that students are always enthusiastic about the biology learning process, especially if the material being discussed is directly related to their daily experiences. Meanwhile, the topic that will be discussed in this research-based teaching material is the topic of bio-growth. When compared to the topic of biophysics and biochemistry, the topic of bio-growth is much more contextual because it can be seen in real terms. So, there is a huge opportunity for this topic of bio-growth to attract students' interest in learning.

The results of interviews with lecturers of biology courses, on average, lecturers think that students are interested in biology courses, one of which is because of practicum activities and field trips. Because with a field trip, learning will be more interesting and not boring so that it creates enthusiasm in learning, creates the same perception and

equates the experience because all children participate in a series of activities. This is in accordance with the opinion (Sagala, 2006), the fieldtrip method is a cruise (excursion) carried out by students to complete certain learning experiences. Fieldtrip activities at the lecture level, especially within the scope of the Biology Department of IAIN Syekh Nurjati Cirebon are also part of learning activities in several courses, especially practical courses.

Meanwhile, according to Djamarah (2006), the field trip method has several advantages, as follows:

1. Field trip has modern teaching principles that utilize the real environment in teaching;
2. Makes what is learned in school more relevant to the reality and needs of society. This kind of teaching can further stimulate students' creativity; and
3. Information as learning material is broader and actual.

According to Roestiyah (2001), the advantage of the fieldtrip method is that students gain learning experiences that are not obtained at school, so that these opportunities can develop students' special talents or skills and students can see various activities in the outside environment so that they can deepen and broaden student experience.

From the explanation above, it can be concluded that there are several advantages of field trip activities carried out by students, this is clearly felt by students including obtaining wider and actual information. The information obtained is more actual because students can immediately see the actual situation. Without field trip activities, students tend to learn knowledge only from literature studies. Fieldtrip activities can also be identified with practicum activities and this is also equivalent to research activities carried out by students.

Based on the lecturer's response, it is said that in addition to field trips, students also like practicum activities. Sagala (2005) explains that the teaching and learning process with this practicum means that students are given the opportunity to experience themselves, follow the process, observe an object, analyze, prove, and draw their own conclusions about an object, state or process.

The tendency of biology students in conducting practical activities can be seen as something very positive, this is because in practical activities many science process skills can be obtained directly by students. This is in line with the opinion of Subiantoro (2010), which states that through practical activities, it is very possible to apply various science process skills as well as to develop scientific attitudes that support the knowledge acquisition process.

Determine the System Potential Delivery (Determine Potential Delivery Systems)

From the results of the analysis of research data, it describes the need for teaching material products that need to be developed in the plant physiology course, especially on the topic of bio-growth. Research-based plant physiology teaching materials are expected to be a solution to overcome problems related to problems in the plant physiology course.

Plant physiology teaching materials with research-based topics of bio-growth, students will study growth and development in plants by collecting data on growth and development in plants. Students will learn through research which has stages of formulating problems, making research procedures, collecting data, processing data and how to analyze research results. Research-based plant physiology teaching

materials are needed because they are in accordance with student needs to achieve the final competencies to be achieved.

The learning objectives of plant physiology which are expected to form students' understanding with the six indicators of understanding according to Wiggins and McTighe (2012), which include interpretation, explanation, application, perspective, empathy and self-knowledge, are expected to be achieved with research-based teaching materials. Research-based teaching materials will train students to be able to analyze data so that understanding perspectives, interpretations, and explanations can be formed.

The use of research-based teaching materials is expected to have a positive impact on students, the good benefit of which is that it can foster a strong link between research and teaching at the higher education level. The research outlined in the teaching materials is expected to make students able to study the material contextually, so that application understanding, empathy, and self-knowledge can be formed optimally (Jenkins & Healey, 2005).

Research carried out by students has many advantages. Besides being able to increase the level of students' understanding of a material, the implementation of research also plays a role in the implementation of higher education dharma. According to Hunaiti et al. (2010), collaboration between research and learning has become the key to success in many world class universities, to produce professional graduates who are ready to conduct cutting-edge research and develop themselves in various disciplines.

Sarwono (2009) explained about the advantages of conducting research conducted by students, according to him research is a step that must be immediately carried out by universities. This step was taken in an effort to increase the competency level of graduates, graduates who are research-oriented will become a strong and high-quality PT that is not merely a diploma-printing university. This is in accordance with the era of industrialization and modernization, universities will participate as centers of research and development of science and technology.

CONCLUSION

There is an imbalance of real conditions with expectations and learning objectives, namely the achievement of the average value of the plant physiology course still does not meet the ideal quality value, which is still in the medium criteria. More than 75% of students feel the need for different teaching materials, namely research-based teaching materials, as well as the opinion of lecturers in the field of biology. Research-based teaching materials are teaching materials that contain research related to lecture materials, therefore research-based plant physiology teaching materials can be an alternative in an effort to improve student understanding.

Recommendations

The findings in this study are expected to be a potential introduction for educators in developing teaching materials according to the needs of their students. Teaching materials need to be developed based on the needs of students because each student has different needs at each level of education. Actualization of research results can be one of the important efforts in increasing the competence of students, especially students who are prospective Biology teachers.

Limitations

The study is limited to biology teacher candidates in IAIN Syekh Nurjati Cirebon-Indonesia. The variables involve the research-based teaching material requirements on bio-growth topic in prospective biology teachers.

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