Development of PjBL Based Interactive E-Modules with a Scientific Approach in Remediating Misconceptions in Biology Subjects

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Abstract. The process of learning activities cannot be separated from learning media. Learning media used has not been able to remediate misconceptions. The media can be used in remediating misconceptions, namely PjBL-based interactive e-module with a scientific approach. This research is R&D research with a development model ADDIE (Analysis, Design, Development, Implementation, Evaluation). The instrument used, Four Tier diagnostic test. Test to find out misconceptions, e-module validation questionnaire given to media experts, material experts and language experts to test and determine the feasibility of the e-module and response educators regarding e-modules and student questionnaires for testing limited trial and extensive trial. The data analysis technique uses descriptive quantitative. The research results show the value of expert suitability media is very decent, namely 89%, the value of material experts is very good decent, namely 90%, very decent linguist score, namely 94%, test score try educators very worthy 89%, limited trials very decent 84%, and widely tested value very feasible 80%, shows that the e-module is suitable for use. Results from n-gain effectiveness test 71.4%, e-module PjBL-based interactive with a scientific approach is quite effective in remediating students' misconceptions about structural material and the function of plant tissue.

1 Introduction

Understanding the concept is very essential in the learning process. It has the meaning of an action to understand the importance of a concept of material that is theoretical or scientific by using intellectual knowledge in understanding the concept of material [1]. Understanding the concept can be obtained from the learning process, when students receive material delivered by educators either in the form of theory or by means of practice, both of which have the same goal of making students understand the concept of learning material [2]. It must be mastered by students. This occurs to support students in comprehending the concept of further material. By understanding the concept of students

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can interpret the results of understanding according to the results obtained in learning activities and if students understand the concept of material correctly according to. However, not all students can understand the concept of the material described, because each student has a different understanding. So that it causes differences in the interpretation of concepts with experts or scientists, this is called misconceptions, concepts can avoid conceptual errors or misconceptions [3]. Misconceptions are often found in biological material, because it is abstract, and has many concepts that students must understand [4]. One of the biological materials that has many material concepts is the structure and function of plant tissues [5]. Many concepts in the material can make it difficult to understand the concept of material, if it continues to result in misconceptions or misconceptions. The statement is in accordance with one of the causes of misconceptions caused by students such as including the results of incorrect reasoning, the stage of cognitive development that is not in accordance with the concept of material, and interest in learning the material. In addition, the causes of misconceptions can be caused by educators, methods, context, and textbooks [6]. Referring to the importance of understanding concepts and factors that cause misconceptions to occur more often in students based on the results of preliminary studies at SMA Negeri 1 Buay Pemanca.

The biggest misconceptions of each material concept can be seen on the concept of totipotency properties which is the highest level of misconception approximately 41%, at the second level, the concept of tissue in plants and its function with 35% and the last is the concept of the structure of plant organ tissue at 32%. Based on the results of the misconception questionnaire, students have difficulty in understanding the concept of plant tissue structure and function material around 87%, belief in the initial concept that is ensured to be correct but in scientific concepts is still wrong as much as 68% besides that students answer questions incorrectly because they do not understand the initial concept of plant tissue structure and function material with a percentage of 74%. The results of interviews with biology teachers on the use of learning media used in plant tissue structure and function material are still limited, by using printed books and Students’ worksheet, and the use of limited media has not been effective. In accordance with the results of the needs analysis, students have difficulty in understanding the material from the books used, and need any learning media that is interesting and practical, besides that students have difficulty in understanding the concept of plant tissue structure and function material. Learners need varied and interactive media. The phenomenon of the results of the needs analysis which tends to make students have difficulty in understanding the learning media used from books, is one of the factors causing misconceptions where the errors in the results of the examination of textbooks often used by students, such as students’ worksheet, with a focus on the concept of plant tissue structure and function material, the results show that there are concept errors in the books used as much as 15%, from nine concept which appear, this happens because the statement in interpreting and expressing the concepts conveyed by misunderstanding, the delivery of concepts that are too broad, the delivery of material that is too simplistic and important concepts are not conveyed fully, and due to the delivery of concepts that are too narrow which can be caused by learning media from textbooks [7] Efforts to overcome misconceptions are by remediating an activity to correct or reduce misconceptions that occur. Remediating misconceptions can be done by developing interactive learning media [8]. One of the learning media that is included in the category of interactive learning media is a thing which enable to make concept understanding and be able to remediate misconceptions that is the interactive e-module [9]. This module can be stored in the form of a website, which is designed and support a website [10]. The use of e-modules can be combined with a various media and it can create a series of learning activities by adding learning models, learning approach and delivering varied materials [11].
The use of interactive e-modules in remediating misconceptions is still rarely used, several previous commitments have been carried out using e-modules to remediate misconceptions, including the development of interactive e-modules using 3D Pageflip as results, a decrease in misconceptions by 52% with the results of validation of e-modules feasible and the response of educators and students is very good [9]. Then in viki et al using interactive e-modules based on cognitive conflicts get results 85.6% (very valid or feasible) [12]. Another study of Verawardana and Ambiyar, found a decrease in remediation of 14.26% from 60.21% before using the module, while the use of interactive multimedia decreased remediation by 0.67% [13].

The success of previous researchers in remediating misconceptions by using e-modules became a benchmark for researchers to develop interactive e-modules in remediating misconceptions. This study developed an interactive e-module based on the Project Based Learning model with a scientific approach. The use of the PJBL learning model can reduce or remediate misconceptions because the project-based learning model can make students understand concepts more clearly and has a series of stages of learning activities that can make students have full involvement directly in the learning process in constructing understanding of concepts, and can build material concepts through problem solving through projects given so that students can search, build and understand concepts by applying directly to project assignments given in the learning process, so that they can make students understand the real concept and avoid conceptual errors or misconceptions.

The scientific approach means a learning approach by prioritizing the scientific method, not only that, the scientific approach looks more at the learning process of students because in learning activities students interact with learning media and other students in carrying out the learning process loading students are fully involved in learning activities. The interactive e-module developed by researchers is an e-module based on a learning model with a learning approach that has never been done by previous research to remediate misconceptions, the PJBL model with a scientific approach, which is implemented in an interactive e-module from a combination of the PJBL model with a scientific approach. The next difference is in the form of presentation of interactive e-module products, with the form of a website and the presence of a homepage display, navigation button display, there is a comment menu at the same time in the form of a Facebook plugin, and a comment column in the form of a software application, while for the application of a combination of PPABL with a scientific approach specifically designed in the e-module according to the material and distributed in each learning activity on the e-module, which can be used to monitor project activities, and students can make project planning or design, collect projects and discuss through interactive e-modules.

Based on the explanation of the background presented by the researcher by examining the learning conditions, the research title "Development of PJBL-Based Interactive E-Modules with a Scientific Approach in Remediating Misconceptions in Biology Subjects" was obtained. The use of interactive e-modules based on PJBL with a scientific approach is expected to remediate misconceptions.

2 Research Methodology

This research conducted is a type of Research & Development (R&D) research. This research uses the Research & Development (R&D) method with the intention of developing a product or creating a new product. The research developed an interactive e-module using the ADDIE design model. The final product will be produced in the form of electronic interactive media, interactive e-modules based on PJBL with a scientific approach that can be accessed on android in the form of a website in remediating misconceptions in biology subjects, the structure and function of plant tissues. The selection of the ADDIE model in
this study carried out the development stages of all stages, starting from the analysis to evaluation stages [14]. The research trial subjects were the details of the population in this study including all students of class X1 MIPA SMA Negeri 1 Buay Pemaca, with a research focus on the material structure and function of plant tissues. The sampling technique used in determining the research sample is cluster random sampling technique. Subject validators in the development research of interactive e-modules based on PJBL with a scientific approach includes two media expert lecturers, two material expert lecturers, two language expert lecturers, and one biology subject teacher. The development trial used 10 students of class X1 SMA Negeri 1 Buay Pemaca as a small-scale trial, and 30 students of class XI SMA Negeri 1 Buay Pemaca as a large-scale trial using.

Data collection techniques are presented in two ways, a test and non-test methods to obtain actual or objective data. For non-test data in the form of a validator questionnaire, a questionnaire for the responses of educators and students, while for the test is a diagnostic four tier multiple choice test with 20 questions.

The data analysis technique used is descriptive quantitative. Non-test data analysis is the analysis of validation data and analysis of learner response data and analysis of educator response data, with the following criteria [15].

**Table 1. Criteria of Questionnaire for The Responses of Educators and Students**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
</tr>
<tr>
<td>Strongly agree (SS)</td>
<td>4</td>
</tr>
<tr>
<td>Agree (S)</td>
<td>3</td>
</tr>
<tr>
<td>Disagree (TS)</td>
<td>2</td>
</tr>
<tr>
<td>Strongly Disagree (STS)</td>
<td>1</td>
</tr>
</tbody>
</table>

Use the following percentage criteria scale [16].

**Table 2. Percentage Criteria Scale**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very worthy</td>
<td>&gt;75-100</td>
</tr>
<tr>
<td>Worthy</td>
<td>&gt;50-75</td>
</tr>
<tr>
<td>Less worthy</td>
<td>&gt;2-50</td>
</tr>
<tr>
<td>Not feasible</td>
<td>0-25</td>
</tr>
</tbody>
</table>

Analyze test data to determine the misconceptions experienced by students use this following criterion table [17].

**Table 3. Criterion of determination the misconceptions experienced by students**

<table>
<thead>
<tr>
<th>No</th>
<th>Kinds of response</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tier 1</td>
<td>Tier 2</td>
</tr>
<tr>
<td>1</td>
<td>True</td>
<td>Sure</td>
</tr>
<tr>
<td>2</td>
<td>True</td>
<td>Sure</td>
</tr>
<tr>
<td></td>
<td>True</td>
<td>Not sure</td>
</tr>
<tr>
<td></td>
<td>True</td>
<td>Not sure</td>
</tr>
<tr>
<td></td>
<td>True</td>
<td>Sure</td>
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<td></td>
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<td></td>
<td>True</td>
<td>Not sure</td>
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<tr>
<td></td>
<td>True</td>
<td>Not sure</td>
</tr>
<tr>
<td>No</td>
<td>Kinds of response</td>
<td>Category</td>
</tr>
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<td>----------</td>
</tr>
<tr>
<td></td>
<td><strong>Tier 1</strong></td>
<td><strong>Tier 2</strong></td>
</tr>
<tr>
<td>1</td>
<td>False</td>
<td>Sure</td>
</tr>
<tr>
<td>2</td>
<td>False</td>
<td>Sure</td>
</tr>
<tr>
<td>3</td>
<td>False</td>
<td>Not sure</td>
</tr>
<tr>
<td>4</td>
<td>False</td>
<td>Not sure</td>
</tr>
</tbody>
</table>

3 Results and Discussion

3.1 Result

Based on the results of non-test data, validator questionnaires, limited-scale and broad-scale trials given to two media experts, two experts, material, two language experts, a biology educator, 10 limited-scale students, and 30 broad-scale students, The interactive module based on PJBL with a scientific approach is very feasible to use and from the results of the diagnostic test. These four tiers of multiple choices misconceptions of students found a significant remediation of misconceptions in the experimental class from the results of this exposure, it can be concluded that the interactive e-module based on PJBL with a scientific approach is very feasible to use and it is able to remediate misconceptions with an effective category based on the results of the n-gain test so that it can be used in teaching. Below is the result information:

Fig. 1. Graphic of Validation Assessment of interactive E-modules based on PJBL with a Synthetic approach
3.2 Discussion

The development process used the ADDIE development model, which has five stages including, analysis, design, development, implementation and evaluation [18]. The initial stages in the development of interactive e-modules based on PJBL with a scientific approach in remediating misconceptions in biology subjects by conducting the analysis.
stage, which is done by doing interviews with educators to find problems that often occur related to misconceptions in biology lessons. The next stage is to give a misconception test in the form of a diagnostic four tier test and a misconception questionnaire. After the analysis stage, the e-module learning media product design stage is carried out by designing products according to the needs of students by designing interactive e-modules to remediate misconception problems that are designed to contain PJBL learning syntax activities and scientific approaches.

E-module menu options, adding navigation buttons on each page, and designing material that is adjusted to the PJBL content with a scientific approach, besides that the e-module is designed based on the demands of KD, KI and the desired learning outcomes, so that it can remediate the misconceptions of students, and design material that has been adjusted to the actual concept of material so that it does not have elements of misconceptions in the learning media that students will use. The layout design of the e-module content is designed with soft colors, and is adjusted to the theme of learning material, both in the form of menu choices, or module backgrounds. In addition, the e-module display is designed by using a website, google sites and canva, so that the e-module will have the final result in the form of an e-module that is stored on the website.

Furthermore, it is carried out with development activities, which the stage of product development that has been designed at the design stage and then tested or in other words simulated.

The implementation stage is to test the quality of the product on the validator, which consists of three areas of validation, namely, media validation, material, and language validation, each of which consists of two validators. Media experts obtained 89%, on the material of 90% and it can be concluded that the material contained in the e-module has met the eligibility category, the results of linguists, namely 94%. Quality testing with educators obtained 89% and included a very feasible category. Furthermore, to get a good quality, a test was carried out on a small scale trial of 84% with a very feasible category, a broad scale trial of 80% for the product feasibility category and including very feasible. Based on the results of the product quality test stage, it can be concluded that it is very feasible to use and ready to be implemented or practiced, at this stage by observing the product that is implemented using an observation tool in the form of a diagnostic four tier multiple choice test, with the aim of knowing the effectiveness of interactive e-modules based on PJBL with a scientific approach whether it is able to remediate misconceptions in students.

The last stage is to evaluate the process of conducting assessment of each subsequent stage by analyzing the results of the product manufacturing process and the results of what has been implemented. Based on the results of each stage, the misconception in the experimental class happened after using the e-module, which shows 16% of students experience misconceptions with a significant difference before using the e-module, which is 40%, according to the criteria for the misconception range category if the percentage of misconceptions is from 0-30 then it is included in the low level of misconception. In accordance with the results of misconceptions at the time before using the new media, the misconceptions of students are still at a moderate level. Learning media has an important role in the process of absorbing knowledge conveyed by educators during the learning process, and learning media is one that can cause misconceptions because it has the potential for students to experience misunderstandings in interpreting each concept contained in the learning media used, besides that misconceptions are often caused by personal experience, and the delivery process in learning [19].

The state of misconceptions in the control class, students still experience changes in misconceptions but not significantly and still in a moderate misconception position. The results of misconceptions in the control class are still fairly many students who experience
misconceptions, namely with a percentage from 43% to 34%. This situation certainly has
driving factors that result in students still experiencing many misconceptions, one of which
is in terms of the use of learning media used during the learning process, in the control class
using textbooks, namely students’ worksheet in the learning process every day and making
students bored. In accordance with the results of interviews with educators who get the
conclusion that students are less active in the learning process, tend to be passive, and
students are often mistaken in interpreting the results of the material being studied. This
situation can provide a great opportunity for students to experience misconceptions, namely
with the process of passive learning activities, active learning activities can provide space
for educators and students in exploring the concept of material, and it would be better if
there was reflection, and there were problem-solving activities, and there were more
interesting and interactive media to minimize students' misconceptions [20].

Based on the results of pretests and posttests that have been carried out, it can be
concluded that the experimental class is able to remediate misconceptions, namely from the
category of moderate misconceptions to the category of low misconceptions, by using e-
modes in the learning process, while in the control class the misconceptions experienced
by students are still classified as moderate or no change. The results of the effectiveness test
using n-gain, namely by comparing the results of the pretest and posttest scores from the
experimental and control classes, get results for the experimental class which is 71.4% and
is classified as quite effective in remediating students' misconceptions. Based on the rules
that apply to the results of n-gain which is 55% -75% is classified as quite effective and
can be used in learning even though it is quite effective [21].

The condition of the results of interactive e-module media based on PJBL with a
scientific approach that is quite effective in the process of remediating misconceptions has
factors that result in this, namely from the difficulty of correcting misconceptions because
they are resistant [22]. In addition, the cause of misconceptions due to the main factor is
sourced from within students, because it is caused by personal experience, students' belief
in the initial concept that is considered correct, and from the habitual mindset in
analogizing and interpreting every picture, word, sentence [23].

The results of the exposure of pretests and posttests and the results of the interpretation
of n-gain can be concluded that the interactive e-module based on PJBL with a scientific
approach is very feasible to use in learning and is quite effective in remediating the
misconceptions of students on the material structure and function of plant tissues.

Designing project planning by asking questions, preparing schedules and collecting
information, monitoring projects integrating the scientific approach, such as associating /
reasoning, and syntax testing results and evaluating experiences with the stage of
communicating [24].

The website e-module is equipped with evaluation questions in the form of four tiers
that can be used to practice the ability to solve questions after the process of understanding
the material. In addition, it has project activities that are in accordance with the basic
competencies of the structure and function of plant tissue material. Each concept of
material that has misconceptions is applied in the interactive module based on PJBL with a
scientific approach because the learning model and learning approach affect one's
understanding in the process of absorbing cognitive knowledge [25].

The results of each learning indicator after using the e-module for the experimental
class on all indicators, experienced a decrease in misconceptions from moderate to low
misconceptions, which experienced by students below 20%, while for the control class did
not experience a decrease in the misconception category, which was still classified as a
moderate category, the percentage of misconceptions above 30%. These results indicate a
decrease in misconceptions after using interactive e-modules based on PJBL with a
scientific approach. The learning process using interactive e-modules based on PJBL with a
scientific approach in the experimental class is carried out according to the PJBL syntax and scientific approach, learning activities in the experimental class students at the end of learning will produce the products, which are in accordance with the results of solutions obtained by each student to solve problems that have been displayed in the e-module. students will produce different products in each group for the products produced by students producing two products because there are two problems displayed in each material according to the sub-concept of the material.

4 Conclusion

Based on the results of research and development of interactive e-modules based on PJBL with a scientific approach that has been carried out, it can be concluded: The process of developing interactive e-modules based on PPA with a scientific approach is carried out using the ADDIE development model, Analysis, design, development, implementation, and evaluation. The feasibility of interactive e-modules based on PJBL with a scientific approach after validating and revising by 3 experts, media experts getting a percentage of feasibility of 89%, material experts 90% and for linguists have feasibility with a percentage of 94%. Based on the results of the feasibility test of interactive e-modules based on PPA with a scientific approach "very feasible" to be developed. The effectiveness of interactive e-modules based on PJBL with a scientific approach obtained an effectiveness percentage of 71.4% and included in the category quite effective in remediating misconceptions in biology subjects, especially on the material of the structure and function of plant tissues after being implemented at SMA N I Buay Pemaca.

Based on the results of research and development of interactive e-modules based on PJBL with a scientific approach that has been carried out, recommendations can be made for Educators can use interactive e-modules based on PPA with a scientific approach in remediating students' misconceptions. For Learners, PJBL-based interactive e-modules with a scientific approach can make students learn independently or be guided by educators and can develop their abilities according to the actual concepts by scientists. For School, the interactive E-module based on PJBL with a scientific approach can be developed in a sustainable manner with different materials. For other researchers, it is expected to develop interactive e-modules based on PPA with a scientific approach with different materials, the number of respondents at the implementation stage can be multiplied, the action of remediating misconceptions is carried out by making learning media whose final results can make PPA products based on concepts and each material indicator that has misconceptions to get better research results.

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