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Guided Inquiry Learning Module with Multimedia Assisted on Cell Metabolism for XII Grade of Senior High School

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Abstract: The aim of this development research was to determine the validity, effectiveness, and practicality of the guided inquiry learning module assisted by multimedia on cell metabolism. This study adapted the research and development from Lee and Owen model. The validity of modules and multimedia as a product is known from the validation scores of experts, while the practicality is known from biology teacher and student responses, and the effectiveness from student learning outcomes. The results showed that the average module expert validation score was 89.67% (very valid), material experts were 100% (very valid), media experts were 96.67% (very valid) and field practitioners were 87.50 (valid). Most students gave a positive response to the module by 85.08% and on the media 80,56%. The effectiveness of the development module produces a value of p = 0.13 which means that it can significantly improve student learning outcomes. Based on these results, it can be concluded that the guided inquiry learning module with mutimedia assisted on cell metabolism is valid, effective, and practical so that it can be used more continued on XII grade senior high school students.

Key Words: module, guided inquiry, multimedia, cell metabolism

Abstrak: Tujuan penelitian pengembangan ini adalah untuk mengetahui kevalidan, keefektifan, dan kepraktisan modul belajar inkuiri terbimbing berbantuan multimedia pada materi metabolisme sel. Penelitian ini mengadaptasi model penelitian & pengembangan Lee dan Owen. Kevalidan modul belajar dan multimedia sebagai produk diketahui dari skor validasi para ahli, sedangkan kepraktisan diketahui dari respon guru biologi dan siswa, sedangkan keefektifan diketahui dari hasil belajar siswa. Hasil penelitian menunjukkan bahwa rerata skor validasi ahli modul sebesar 89,67 % (sangat valid), ahli materi sebesar 100 % (sangat valid), ahli media sebesar 96,67 % (sangat valid) dan praktisi lapangan sebesar 87,50 (valid). Sebagian besar siswa memberikan respons positif terhadap modul sebesar 85,08 % dan terhadap media 80,56%. Efektivitas modul pengembangan menghasilkan nilai p = 0,13 yang artinya secara signifikan dapat meningkatkan hasil belajar siswa. Berdasarkan hasil tersebut, dapat disimpulkan bahwa modul belajar inkuiri terbimbing berbantuan multimedia pada materi metabolisme sel yang dikembangkan tergolong valid, efektif dan praktis sehingga dapat digunakan lebih lanjut pada siswa kelas XII SMA.

Kata kunci: modul, inkuiri terbimbing, multimedia, metabolisme sel

INTRODUCTION

Student-centered learning is one of the characteristics of active learning that can be applied using the inquiry model (C.Khulthau, K.Maniotes, & K.Capsari, 2007). Inquiry learning process involves students active participation such as asking questions, looking for relevant literature/references, analyzing and interpreting data, discussing and communicating results. Inquiry learning requires a logical and critical thinking (Pedaste et al., 2015)

The application of learning models, teaching materials and learning media used by teachers influence student learning outcomes. If it is not in accordance with the characteristics of the material being taught, then the opportunity to obtain learning outcomes that are in line with expectations will be lesser (Osman, Hiong, & Vebrianto, 2013). The application of the

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guided inquiry learning model can be facilitated with a teaching material. One of the teaching material that has the characteristics of containing a planned, systematic learning experience and designed to help students achieve specific learning goals is a module (Ash-Shiddieqy, Suparmi, & Sunarno, 2018)

Material organization in modules contains sequencing patterns that refer to the making of of subject matter presentations, and synthesizing which refers to efforts to show students about the interrelationship between facts, concepts, procedures, and principles contained in learning material (Adnyana & Citrawathi, 2017). Integration of the application of science and technology today in the educational setting is growing very rapidly. One of the usage of technological progress in the educational setting is related to a media of learning (Khan & Masood, 2012). Learning media is used to facilitate abstract understanding of ideas and concepts (Keleş & Kefeli, 2010).

One effort that can be done to support success in the learning process is to take advantage of technological developments (Osman et al., 2013). The development of information technology and computers now has a significant influence in the world of education, including the development of learning media (Zanin, 2015). The presence of technology has been able to integrate various types of media into a learning model, called computer aided instructional (Joshi, 2012). The use of media developed from electronic devices in learning activities shows better results than conventional learning (Chinna & Dada, 2013)

The need analysis and studies that have been carried out on teaching materials used in Basic Competence 3.2, namely explaining metabolic processes as enzymatic reactions in living things and 4.2 compiling reports on experimental results about the mechanism of enzyme action, photosynthesis, and anaerobic respiration, indicates that the material presented is less able to encourage students to develop 21st century skills such as critical thinking and scientific literacy. Presentation of the phenomena given to the teaching materials and practice questions that lack sharpening critical thinking skills and scientific literacy. The teacher also has not developed a teaching material that can accommodate for the improvement of 21st century skills. The practice questions given in the student book are predominantly C1 and C2 according to the Bloom Taxonomy. The learning media used in Darul Ulum 2 High School Jombang on cell metabolic material using Microsoft Powerpoint and videos obtained from youtube are not well organized and interesting.

The results of the needs analysis that have been filled in by XII grade students and biology teachers state that a teaching material that can accommodate for the development and improvement of 21st century skills and learning media to help the student understand about metabolism is required. Teaching materials compiled are in the form of modules, since a systematic arrangement of certain basic competencies and the use of modules in learning enables efficient, effective and relevant learning (Chao, Lin, & Wang, 2015) and it can help the students who have learning difficulties (Ministry of National Education, 2008). The use of instructional media on abstract ideas and concepts will be able to help students (McClean et al., 2005)

The purpose of this study was to develop teaching materials in the form of guided inquiry modules assisted by multimedia for cell metabolism topic. The place of this research was conducted at SMA Darul Ulum 2 Jombang. Module and multimedia development refers to the procedure from Lee and Owens model (2004). The reason for choosing the development model is because of the multimedia elements that are integrated in the learning modules that will be used in the learning process.

METHOD

The development model used in this study was Lee and Owens model. Lee and Owens's development model includes five systematic stages of activity, (1) analysis consisting of two main parts, namely need assessment and thorough analysis of front-end analysis, (2) design, (3) development, (4) implementation, and (5) evaluation (Lee & Owens, 2004). The study was conducted at SMA Darul Ulum 2 Jombang from May to September 2018. In the first stage, the analysis, the development model of Lee and Owens (2004), was divided t into two main stages, namely: (a) needs analysis, information collection done by observation and interviews with XII graders and biology teachers by filling out questionnaires, (b) front-end analysis, this process is to obtain more accurate information about students, teachers and facilities in schools.

The second stage was design. This stage was the planning of guided inquiry module assisted by multimedia. Design planning was as follows: schedule set-

ting, project team determination, media specification determination, module design preparation and storyboarding for multimedia learning. The third stage was development. This stage consists of: pre-production, production stages which include the editing process, adding media needed, post-production stages, which consists of the following stages; Validity tests involve material experts, module experts and multimedia experts. Module and multimedia validation. Assessment by field practitioners was conducted by biology teachers, and material expert validators.

The fourth stage was implementation. The implementation process is carried out to test the feasibility of the product in the actual learning conditions. The fifth stage was evaluation. It was done to assess the results of the validity of modules and multimedia as a product. Data in this study consisted of two types of data, namely quantitative data and qualitative data. Qualitative data was obtained from responses, suggestions given by material experts, module experts, multimedia experts, field practitioners/teachers and student response. Quantitative data was obtained from the questionnaire scores of responses from the validators and student learning outcomes. The quantitative data that has been obtained will be calculated and converted to the validity level of the product. The conclusions from each aspect of validation can be seen in accordance with Table 1.

RESULT

This study uses the development model from Lee and Owen (2004) which includes five systematic stages of activity, namely (1) analysis consisting of two main parts, namely Needs Analysis and comprehensive analysis of Front-end Analysis, (2) design, (3) development, (4) implementation, and (5) evaluation.

Analysis Stage

The stages consist of two main parts, namely Needs Analysis and comprehensive analysis of Front-end Analysis. Needs assessment activities are carried out to gather information about real conditions in the field as well as suitable solutions for the development of guided inquiry modules with assisted multimedia on cell metabolism. Information collection was carried out by observation and interview of XII graders and biology teachers at SMA Darul Ulum 2 Jombang. Needs analysis shows that there is a need for teaching materials that can be used independently. Teaching materials in the form of modules are also accompanied by multimedia since in the material of cell metabolism there are many abstract concepts. Front-end analysis shows that students and teachers using computers/laptops and school infrastructure facilities are sufficient for multimedia utilization in the learning process.

Design Stage

The guided inquiry module created for cell metabolism material consists of three learning activities, namely: learning activities 1 about enzymes, learning activities 2 about catabolism, and learning activities 3 about anabolism. Each learning activity is equipped with Bio inquiry, bio analysis, bio lab, bio multimedia, self evaluation, glossary and summary. Multimedia development has several elements such as audio, video, images to assist students' understanding on cell metabolism material. The software that will be used in the development of metabolism material is Adobe flash 5. The use of learning multimedia requires a minimum specification of a computer or laptop, as follows; (1) pentium IV processor; (2) 512 Mb RAM; (3) 1024 x 768 resolution; (4) CD-ROM; (5) 16 bit VGA; (6) Windows XP operating system; and (7) hard disk free space capacity of at least 150 Mb.

Development Stage

Validation assessment by Expert Validator

The results of the validation by experts validator qualitatively and quantitatively can be seen in Tables 2 and 3.

Table 1. Product Assesment Criteria

Achievement level	Validity criteria	Level of validity
85, 01% - 100 %	Very valid	Very valid, can be used
70,01 % - 85 %	Valid	Valid, can be used but need some revision
50,01% - 70 %	Less valid	Less valid, need more revision
1,00 % - 50 %	Not valid	Not valid, not siutable for use

Table 2. Results of The Validation

No	Product evaluation aspect	Validator	Instrumen	Result (%)	Category
1	Material Validity	Material expert	Validation sheet	Rev 1 = 69 %, Rev 2 = 100 %	Very valid
2	Module Validity	Module expert	Validation sheet	89,67 %	Very valid
3	Multimedia Validity	Multimedia expert	Validation sheet	96,67 %	Very valid
4	Module Validity	Biology teacher	Validation sheet	87,50 %	Very valid
5	Multimedia Validity	Biology teacher	Validation sheet	85,08	Very valid
6	Module attractiveness	Student	Questionnaire sheet	80,08 %	Valid
7	Multimedia attractiveness	Student	Questionnaire sheet	80,56 %	Valid

Table 3. The Result of The Data are Validated Qualitatively

Validator	Note and revision
Material expert	1. For learning activities 1. The structure of the enzyme is replaced by an image that can show a more detailed and relevant form of the active site. 2. For learning activities 2. Images of the stage of respiration processes need to be added to make it clear. 3. For glossaries the term is more added
Multimedia expert	1. To add multimedia appeal, it is necessary to provide a better color composition 2. For the multimedia accompaniment music can be used which is giving a sense of spirit. 3. For the operation of the button is made more simple, so it is easier to use
Module expert Biology teacher	1. The layout for indicators and learning objectives at the beginning of the topic of learning must be arranged better. 2. For each image, check the contrast colour and reference source. 3. For each section inside the module must be given the purposes, for example bio inquiry, bio analyisis, bio multimedia. 4. *Lay out* needs to be rearranged to increase student interest during learning, it is necessary to add appropriate illustrations.

Table 4. Hypothesis Test Results of Student Learning Outcomes in SMA Darul Ulum 2 Jombang

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6336,438[a]	3	2112,146	20,388	,000
Intercept	32141,120	1	32141,120	310,246	,000
X1	662,518	1	662,518	6,395	,013
Y	5792,737	2	2896,369	27,958	,000
Error	8909,487	86	103,599		
Total	437753,950	90			
Corrected Total	15245,925	89			

Implementation Stage

The implementation process is carried out to test the feasibility of the product in the actual learning conditions. Small group trials were conducted through product review activities on 30 students (based on the average number of class students) students of class XII of SMA Darul Ulum 2 Jombang. The results of product trials in the form of student responses are used to make improvements to the product design developed. The results of the implementation can be seen from Table 2.

The implementation process was carried out by quasi-experiment using three classes; negative control with conventional learning, positive control using a guided inquiry model (without the development module) and the treatment class using a guided inquiry learning model and using the development module. The data obtained were analyzed by the Anacova technique. Based on the quasi-experimental activities, the students' learning outcomes data were obtained to find out the effectiveness of the development modules. Learning outcomes data are seen in the Table 4.

Based on the table above, it shows that there are significant differences in student student learning outcomes between the negative (Y) class, positive control, and treatment class (using the development module) with a value of $p = 0,000 < 0.05$. The table presentation shows that there was a significant increase in student learning outcomes (X1), because the value of

$p = 0.013 < 0.05$. These results indicate that the use of modules is very effective since it can significantly improve student learning outcomes.

Evaluation Stage

At this evaluation stage, it aims to find out whether product development can be used in the learning process. This stage accommodates the suggestions given by the validators (material experts, module experts, multimedia experts, and practitioners/ Biology teachers). The product is repaired according to the suggestion given.

DISCUSSION

The learning process can run well and meaningfully, if in the learning process the teacher uses a teaching material and media that is in accordance with the character of Basic Competence (Veselinovska, Gudeva, & Djokic, 2011). The appropriate components of teaching materials and learning media will be able to help smooth student learning. Integrating media in a guided inquiry learning model is the right step to improve the learning process that is more meaningful. The application of the guided inquiry learning model can be facilitated with a teaching material (Ural, 2016). One of the teaching material that has the characteristics of loading a planned learning experience, systematic and designed to help students achieve specific learning goals is a module.

Modules are one of the printed materials that are printed and packaged in full and systematic. The learning module contains learning experiences that have been arranged well and are planned to facilitate students to be able to achieve learning goals in more de-tail (Ministry of National Education, 2008). The preparation of modules has the purpose of facilitating and clarifying the messages conveyed because they are visual and not too verbal, provide solutions to problems of time constraints that may be faced by teachers and students, and provide convenience for students in evaluating their learning outcomes because the module is equipped with a feedback sheet (Ministry of National Education, 2008). The use of module in the learning process can provide benefits, in this case the teacher and students can evaluate and find out on the part or topic where students have not mastered or have successfully mastered the topic (Ministry of National Education, 2010).

Learning using module has several advantages, namely the module is more focused on the ability to learn independently and is responsible for the actions taken, the module can be used as a control of student learning outcomes, modules have relevance to the curriculum (Zuliana, Subiyanto, & Aji, 2014). Another advantage gained from the use of modules is that it can increase learning motivation, as an independent evaluation tool to detect topics where students experience difficulties in learning

The use of module can also be supported by a learning media, because the media can help students understand about the abstract material (Wijarini et al., 2014; Svec, 2017). The use of elements in the form of text, images, audio, and video in multimedia learning can illustrate the whole concept of a material. Mastery of concepts that can be obtained from multimedia can help develop student skills. The addition of an illustration of natural phenomena presented to the media will also be able to develop students' scientific literacy skills (Udompong & Wongwanich, 2014). The use of media in learning can facilitate students in understanding something abstract to be more concrete so that they can motivate students to learn (Ristanto, Zubaidah, Amin, & Rohman, 2018)

This research and development produces products in the form of guided inquiry learning modules with multimedia assisted in cell metabolism chapter. The module is developed using Lee and Owen model (2004). This module is structured according to guided inquiry syntax. Modules that have been developed in general consist of three main parts, namely the beginning, the core, and the final part. The initial part of the module consists of the module cover, title page, introduction, table of contents, and module usage instructions. The core part of the module consists of learning activities 1 (enzymes), learning activities 2 (catabolism), and learning activities 3 (anabolism), each of which has Basic Competencies, indicators of learning, learning objectives, material descriptions, student activity sheets (LKS), and independent evaluation. The final part of the module is a summary and glossary.

Learning activities in the module consist of three activities. The activity of learning 1 about enzymes, which discusses the characteristics of enzymes, how the enzymes work, the factors that affect the workings of enzymes. Learning activity 2 about catabolism, which discusses cell respiration by aerobes and anaerobes, stages in cell respiration, initial compounds. Learning activity 3 about anabolism, which discusses

the stages of photosynthetic reactions in light and dark reactions, explains the process of light and dark reactions and their results, factors that influence photosynthetic reactions.

The advantages of this guided inquiry module with multimedia assisted in cell metabolism, when it compared to another teaching materials which are components in guided inquiry module with multimedia assisted can improve students' abilities related to 21st century skills. Guided inquiry module with multimedia assisted has 4 sections that are characteristic of the module produced, namely; (1). Bio Inquiry, this section will be given observation problems related to the topic of learning. This section is useful for stimulating students to think about finding a concept that relates to daily life or is contextual in nature, and invites students to explore topics that are learned. Student activities can also include analyzing images/ graphs to find a concept related to the topic being studied. (2). Bio Analysis, this section is given a question that can improve students' scientific literacy skills and critical thinking skills. The types of questions given are essay questions with certain cases related to the topic of learning. (3). Bio Lab, in this part the student will carry out practical activities in the biology laboratory, this activity can improve skills for K.I.4, there are 3 practical activities that students will do in this metabolic learning material. (4). Bio Multimedia, in this part the student will carry out learning activities in a computer laboratory to analyze animations or videos related to the topic of learning. In addition there are independent evaluations, this part of the student is presented with multiple choice exercises and can also be a brief description to measure understanding of the topic being studied. In the end there is a glossary and summary, this section presents definitions of important terms related to metabolic learning material and summaries of metabolism. Some layouts of guided inquiry learning module are seen in the Figure 1.

Multimedia learning produced has three section of learning activities, namely: learning activities 1. Enzymes, learning activities 2. Catabolism, and learning activities 3. Anabolism. Every learning activity has video media, graphics, and pictures that are related to the topic of learning. It was created in the form of Macromedia flash, are seen in the Figure 2.

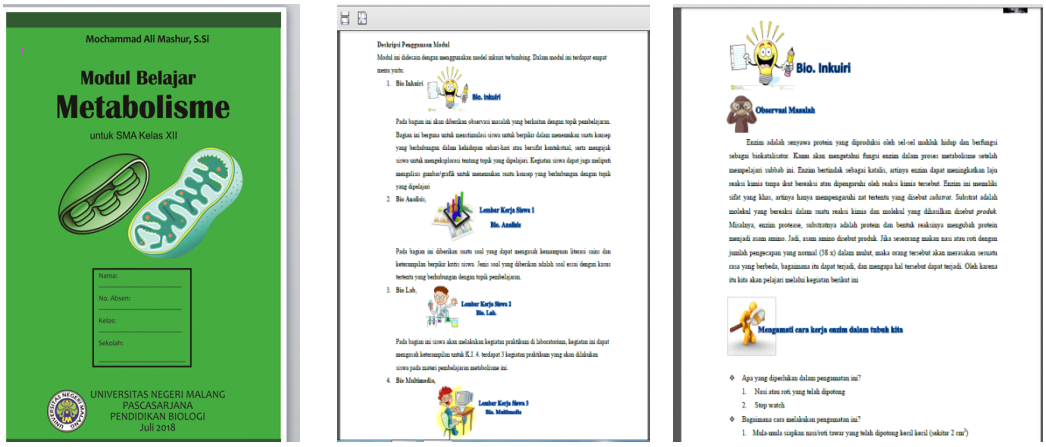

Figure 1. Guided Inquiry Learning Module Layout

Figure 2. Multimedia Learning

CONCLUSIONS

Products of developing instructional materials are guided inquiry learning modules with multimedia assisted in cell metabolism. Guided inquiry learning modules assietd by multimedia have been revised based on the results of expert validator evaluations (material, module, and multimedia). The guided inquiry learning module with multimedia assisted produced has characteristics that are activities (1) Bio Inquiry, (2) Bio Analysis, (3) Bio Lab, (4) Bio Multimedia. Validation results show the percentage of validity obtained from the validator and small group trials, and result from student learning outcomes, guided inquiry learning mod-ule with multimedia assisted in cell metabolism was developed has met valid, practical, and effective criteria and can be implemented in the XII grade of senior high school.

Suggestions that need to be considered are as follows; (1) need for further research by implementing interactive multimedia in the learning process with different chapter, so that they can be known the influence student learning outcomes, or can also be associated with their influence on 21st century skills, such as critical thinking skills, scientific literacy, creative thinking skills, etc. (2) socialization of the module needs to be done, at least in the discussion forum of MGMPS (School Level Subject Teacher Consultation) and at the district level.

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