

The Validity of Biology Module for Senior High School on Grade X in Even Semester Based on Critical Thinking Skills

Nor Aqidatul Husna ^{(1)*}, Muhammad Zaini ⁽¹⁾, Ateik Winarti ⁽²⁾

⁽¹⁾ Master of Biology Education, Lambung Mangkurat University, South Kalimantan, Indonesia, 70124

⁽²⁾ Chemistry Education Study Program, Department of Mathematics and Science Education, Faculty of Teacher Training and Education, Lambung Mangkurat University, South Kalimantan, Indonesia, 70124

*Corresponding Author Email: aqidatulhusnanor@gmail.com

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Abstract

Biology learning in schools still experiences several problems. The learning process carried out has not optimally fulfilled the demands of the Education Curriculum, including in helping students to have critical thinking skills. Critical thinking skills can be optimized by developing learning modules. This study aims to obtain a valid biology module based on critical thinking skills for SMA/MA students. The module development method uses Tessmer's research and development design model that focuses on formative evaluation. The module developed refers to six kinds of critical thinking skills according to Facione, including interpretation, analysis, evaluation, inference, explanation, and self-regulation. Data obtained from the validity test by three validators. The percentage of expert validation data was then categorized. Data analysis used the descriptive technique. The biology learning module based on critical thinking skills that were developed as a whole obtained very valid criteria.

Abstrak

Pembelajaran Biologi di sekolah masih mengalami beberapa permasalahan. Proses pembelajaran yang dilaksanakan belum secara optimal memenuhi tuntutan Kurikulum Pendidikan, diantaranya dalam membantu peserta didik untuk memiliki keterampilan berpikir kritis. Keterampilan berpikir kritis dapat dioptimalkan dengan mengembangkan modul pembelajaran. Tujuan dari penelitian ini adalah untuk mendapatkan modul biologi yang berbasis keterampilan berpikir kritis pada peserta didik SMA/MA yang valid. Metode pengembangan modul menggunakan model desain penelitian pengembangan dari Tessmer yang fokus pada evaluasi formatif. Modul yang dikembangkan mengacu pada enam macam keterampilan berpikir kritis menurut Facione, meliputi interpretasi, analisis, evaluasi, inferensi, eksplanasi dan regulasi diri. Data diperoleh dari uji validitas oleh tiga validator. Persentase data validasi ahli kemudian dikategorisasi. Analisis data menggunakan teknik deskriptif kategorisasi. Modul pembelajaran biologi berbasis keterampilan berpikir kritis yang dikembangkan secara keseluruhan memperoleh kriteria sangat valid.

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A. Introduction

XXI century is filled with many changes including changes in the educational paradigm. Education in this century is Student-Centered. According to Friedman (in Sudarisman 2015) students in this XXI century need to be equipped with higher-order thinking skills (HOTS) to be able to think critically, logically, reflectively, metacognitively, and creatively. In technological advances in the XXI century, everyone is required to have complex skills, such as being able to develop and maintain skills and proficiency in terms of work, one of which aims to overcome competition in various countries (Tremblay, Lalancette, & Roseveare, 2012). For this to be resolved, of course, everyone will be required to have various kinds of skills, one of which is the skills in higher-order thinking, one of which is critical thinking.

According to Anderson (2000), the tendency of science learning in the XXI century is ideally directed at communication; collaboration; critical thinking and problem solving; and creativity and innovation (4C).

Critical thinking is part of the cognitive abilities needed so that a person can avoid mistakes and hasty decisions so that the truth can be guaranteed (Sumarni *et al.*, 2018). Students have important critical thinking skills in the learning process, both in formulating problems and concluding.

The 2013 curriculum also demands that the learning material be metacognitive in the hope that students can predict, design, and predict. This applies to every subject including biology. The implementation of this curriculum has been good but still needs to be optimized.

Biology plays a very strategic role in preparing critical, creative, and competitive students. Also, students are expected to be able to solve problems and dare to make decisions quickly and correctly, what can be done to help students get optimal learning, one of which is by developing teaching materials. According to Hernawan *et al.* (2012), teaching materials have a very important role in learning activities, teaching materials are equipped with learning objectives or competencies to be achieved, learning materials, learning procedures, activity sheets, formative tests/feedback, and bibliography such as learning modules. One of the functions of teaching materials is to assist teachers in carrying out teaching and learning activities. For teachers, teaching materials are used to direct all their activities and what should be taught to students in the process of teaching and learning activities. Then, students, they will make it a guide in the learning process. Teaching materials can function in individual learning which can be

used to organize and supervise the process of obtaining information from students. The teaching material is a module (Nurdiyansyah, 2018).

This developed biology module is used as a learning resource that can make it easier for students in the process of teaching and learning activities. Modules are made practical, do not use language that is too formal, systematically structured, and easy to understand. Modules for students generally use independent and group learning methods. According to Khasanah *et al.* (2017), a module based on critical thinking skills developed following indicators of critical thinking skills and dimensions of knowledge visualized on objectives, materials, activities, and evaluation questions can provide a significant difference between the learning outcomes of students using this module and teaching materials in schools.

The development of this module is expected to help the teaching and learning process in the classroom and become an assistive medium so that learning runs effectively. Also, through module development, students can gain direct experience, think scientifically, creatively, focus, and dare to express something. This ability can provide strength for students to accept, store, and produce impressions of what they learn. Based on the above conditions, it is necessary to make efforts to optimize the learning process by researching to develop a biology module based on valid critical thinking skills.

The development of critical thinking skills-based modules can significantly improve student learning outcomes (Khasanah *et al.*, 2017). The developed module based on critical thinking skills with validation results can effectively improve the learning outcomes and critical thinking skills of students (Pratiwi *et al.*, 2018).

To ensure that the biology module developed is following the criteria for module preparation, it is important to conduct a validity study of this module.

B. Materials and Method

Research on the development of high school biology modules based on critical thinking skills is classified into quantitative descriptive research with development research methods. This module development research uses Tessmer's formative evaluation design, which includes self-evaluations, expert reviews, one-to-one evaluations, and small group evaluations, and field tests. This research focuses on the Expert Review stage (Expert Validation) in the Prototyping Phase. Expert validation involves three lecturers (biologists and instructional media experts). The expert validation

instrument used was adapted from the LPMS Team, which was then validated on one instrument validator before being used in the module validation process. After that, the module validation was carried out by the validator, namely three expert experts

The validator will analyze the module and provide suggestions and input on the module design. The validation of material experts will validate the suitability of competencies and indicators with the modules that will be developed. Validation of construction experts validates the suitability of the presentation of the material with the developed construction. Linguist validation validates the suitability of the language used with the developed module. Validation is carried out so that the resulting module is said to be valid. The instrument used was a validation questionnaire to obtain data about the opinions of the experts (validators) on the modules compiled in the initial design. This instrument will serve as a guide in revising the compiled modules.

The results of module validation are accumulated, then the percentage is calculated using the formula:

$$\text{percentage of validity} = \frac{\text{score obtained}}{\text{maximum score}} \times 100\%$$

The percentage of the validity of the developed modules is then categorized based on Table 1.

Table 1 Validity Criteria

Score	Validity Information	Information
80,1-100%	Very valid	<i>Can be used without revision</i>
60,1 -80%	Valid	<i>Can be used with minor revisions</i>
40,1-60%	Quite valid	<i>Can be used with moderate revisions</i>
20,1-40%	Less valid	<i>Not yet usable needs major revision</i>
0-20%	Invalid	<i>Cannot be used, needs total revision</i>

Source: Adapted by Akbar (2013)

C. Results and Discussions

The content validity of the Biology module based on critical thinking skills includes five aspects, namely material aspects, language, presentation, format, and module assessment in supporting innovation and improving teaching and learning activities. The results of expert validation on the developed biology module can be seen in Table 2

Table 2 Results of Expert Validation on the Biology Module

Aspect	Indicator	Module I		Module II		Module III		Module IV		Percentage average validation score	Criteria			
		Validator		Validator		Validator		Validator						
		I	II	III	I	II	III	I	II			III		
Theory	1. The truth of content (facts, concepts, principles, laws, theories, and scientific processes)	4	4	4	4	4	4	4	4	4	3	4	97,73%	Very valid
	2. Up-to-date content.	3	3	3	3	3	3	3	3	3	3	3	75,00%	Valid
	3. Paying attention to the attachment of this module content to its implementation in learning that is appropriate to the local environmental context	3	3	3	3	3	3	3	3	3	3	3	75,00%	Valid
	4. Systematic, according to the scientific structure	4	4	4	4	4	4	4	4	4	4	4	100%	Very valid
Language	1. Readability in accordance with target readers, especially students	4	4	4	4	4	4	3	4	4	4	4	97,92%	Very valid
	2. Using good and correct Indonesian	4	3	3	4	3	4	4	3	3	4	4	89,58%	Very valid
	3. The terms used are precise and understandable	4	4	3	4	4	4	4	4	3	3	3	91,67%	Very valid
	4. Using language that is communicative and effective	4	4	4	4	3	3	4	3	4	3	3	87,50%	Very valid
Presentation	1. Generating motivation/ interest/curiosity.	3	3	3	3	3	3	3	3	3	3	3	75,00%	Valid
	2. In accordance with the	3	4	3	3	3	3	4	3	3	3	4	83,33%	Very

Aspect	Indicator	Module I			Module II			Module III			Module IV			Percentage average validation score	Criteria
		Validator			Validator			Validator			Validator				
		I	II	III	I	II	III	I	II	III	I	II	III		
	level of thinking and ability														valid
	3. Encourage students and readers to be actively involved	3	3	3	4	3	3	4	3	3	3	3	3	79,17%	Valid
	4. Interesting/fun	3	3	3	3	3	3	3	3	3	3	3	3	75,00%	Valid
Format	1. Module is equipped with module systematics	4	4	4	4	4	4	4	4	4	4	4	4	100%	Very valid
	2. The numbering system is clear	4	4	4	4	4	3	4	4	3	4	4	4	95,83%	Very valid
	3. Balanced text and illustrations.	3	3	3	3	3	3	3	3	3	3	3	3	75,00%	Valid
	4. The type and size of the font (letter) are appropriate.	4	4	4	4	4	4	4	4	4	4	4	4	100%	Very valid
	5. The material for each activity is relevant	3	4	4	3	4	4	3	4	4	3	3	3	87,50%	Very valid
	6. Each part is clearly identified	4	4	4	4	3	3	4	4	4	4	4	4	95,83%	Very valid
	7. Bibliography in accordance with the book reference written	4	4	4	4	3	4	4	4	4	4	4	4	97,92%	Very valid
Module Assessment in Supporting Innovation and Improvement of Teaching and Learning	1. Support the independent teaching and learning process	3	4	4	4	4	4	4	3	3	4	3	3	89,58%	Very valid
	2. Able to invite further students' curiosity.	3	3	3	3	3	3	3	3	3	4	3	3	77,08%	Valid
	3. Provides convenience in developing the critical thinking skills of students.	3	3	3	4	3	3	3	4	3	4	3	3	81,25%	Very valid
	4. Provides convenience in making learning evaluation questions.	3	4	3	3	4	4	3	4	4	4	4	4	91,67%	Very valid

The validity of the developed Biology Module resulted from an Expert review conducted by three experts to examine several aspects of module validity such as material, construction, and language measured using the module validation instrument. The expert validation is divided into five aspects of assessment with 23 indicators. The five aspects include material, language, presentation, format, and module assessment in supporting innovation and improving teaching and learning activities.

1. Material Aspects

The material aspect consists of four validity indicators. Two indicators of obtaining very valid results include the truth of concepts (facts, concepts, principles, laws, theories, and scientific processes) with a percentage of 97.73%, and systematically according to the scientific structure of 100%. Two indicators of obtaining valid results include updated content with a percentage of 75.00% and attention to attention to the attachment of module content to implementation in learning according to the local environmental context with a percentage of 75.00%.

This validation activity is carried out to get input on the entire content of the material contained in the module design. The results of the validation

as well as suggestions and input for improvements that have been given by the validator will be used to make minor revisions and besides that, they can also be analyzed to determine the validity of the module both in terms of content and construction. The validation results can be seen in Table 2, if the validation results do not reach at least valid results, the revision will be made to get a valid module that can be used.

Validity that shows the suitability, meaningfulness, and usefulness, the higher the validity of a product, the better the conclusions that can be drawn, and the better the level of meaning and usefulness. Overall, the developed modules fall into the very valid category. The validation results that are very valid in this study cannot be separated from the revised results that come from the input of the validators. Input from the validator helps the module preparation process to meet the criteria from the content validation test aspect. Input which is a constructive suggestion has succeeded in making modules that can be used by students. Following what was emphasized by the Ministry of Education and Culture (2013) that product validation aims to obtain recognition or validation of product suitability with needs so that it is feasible and suitable for use in learning.

The validity of the material aspects that are first assessed is the correctness of the content, the updating of the content, paying attention to the attachment of the module content to its implementation in local learning, systematically, according to the scientific structure. This is done with the aim that the module being developed is balanced between the content of the material and the content. Modules developed that meet the material criteria will become important modules for students to build knowledge or skills based on concepts or principles that are collaborated with learning activities.

The truth of the content regarding facts, concepts, principles, laws, theories, and scientific processes and the up-to-date content of the developed module is based on factual truth and the material presented is still up to date following the latest biological scientific developments with the aim that students can understand the concept correctly. Amelia *et al.*, (2019) stated that the contents of the book must contain facts and concepts that are correct considering the accuracy and coverage of the material. This is in line with research from Prabowo *et al.*, (2016) that the accuracy of the developed module material is declared valid after going through several revisions with material experts. Revision of the validator is made to adjust the material presented with the correct concept. According to Titin (2016), teaching materials should be following the learning objectives, the presentation must be factual. Another thing is also explained by Hosnan (2014), the learning process is arranged systematically so that students can actively construct concepts, principles, or laws through scientific activities.

The attachment of module content to implementation in learning in the context of the local environment is needed to increase students' appreciation of the material content because it is supported by their experiences. According to Titin (2016), a good module should be under the needs of students, which describes the background and atmosphere that students live in and also following the environment for implementing the module to be developed.

The systematic of the module will be reflected in the module content following the scientific structure, a module is arranged systematically with the aim that students can easily understand the content of the material and involve active students in learning. According to Sari (2017), the content of the material must be in line with the needs of the curriculum and the competencies that students must achieve. As a support, the suitability of the image with the discussion is also validated by experts in this case

to avoid the module content that does not match the needs and add ideas about higher quality content. This is in line with Putra *et al.*, (2016) in compiling material in teaching materials, it is very important to pay attention to the suitability of the material content with the curriculum, this is so that the learning material presented can be integrated easily.

Permendikbud (2016) states that the books to be used in learning are designed to develop knowledge, skills, and positive attitudes of students. To achieve this goal, in compiling the book, the things to pay attention to are that it must have feasibility when viewed from the material aspect, linguistic aspect, presentation aspect, and graphic aspect. (Ramadan, 2019).

2. Linguistic Aspects

The linguistic aspect of the validation of this module consists of four validity indicators. The four indicators obtained very valid results. The readability indicator is following the target reader, especially students, getting a percentage of 97.92%. The indicator for the use of Indonesian that is good and correct gets a percentage of 89.58%. Indicators of the accuracy of terms used and can be understood get a percentage of 91.67%. Then, indicators of using language that is communicative and effective get a percentage of 87.50%.

One of the characteristics of a good module is to use language that is easy to understand, clear and appropriate to the age level of students so that it can help students better understand concepts. Good modules arranged in communicative language are expected to facilitate students to learn independently (Khoirudin, 2019).

Good grammar is arranged to facilitate the module later when it is read and can have an immediate impact on providing information for students who use or read the module, one of which is the use of communicative and effective language that will be easily understood by students, sentences in the module are simplified can make students more motivated to use the developed module. According to Jatnika (2007) book readability is determined by two factors, namely language and form. Language includes the choice of words, sentence structure, and paragraph arrangement. The form of grappling letters or typography includes font size, line density, and writing width. According to Istiningrum *et al.* (2016), the content of biology teaching materials should be relatively easy for readers to understand. Other results show that communicative sentences are preferred by readers and increase the readability of writing (Nugrahani 2007; Artama, 2009; Suyitno, 2014).

Based on the results of expert validation, the validators provide many corrections regarding

typing errors, punctuation marks, and even confusing sentences. This is inseparable from the criteria for proper linguistic aspects as one of the components that are considered in compiling the module. Other deficiencies in this aspect have been corrected so that the developed module can meet linguistic criteria that are easy to understand so that the module makes it easier for students to grasp the meaning of the material listed in the module. If students understand the material, the results will be good, especially in increasing critical thinking. This is in line with the opinion of Purnomo *et al.*, (2013) that easy-to-understand writing can improve students' cognitive abilities.

3. Presentation Aspects

The presentation aspect consists of four validity indicators. One indicator of obtaining very valid results is the suitability of the module with the level of thinking and the ability of students with a percentage of 83.33%. Three indicators of obtaining valid results include the advantages of the module in generating motivation/interest/curiosity with a percentage of 75.00%, indicators of excess modules in encouraging students and readers to be actively involved, obtaining a percentage of 79.17%, and the module is declared interesting/fun with a percentage 75.00%.

It needs to be known by an educator that high learning motivation can help students to improve their expected abilities following the goals to be achieved. Many components must be integrated so that students can be actively involved in the learning process and can motivate them, one of which is the teaching materials that are arranged completely and systematically based on the learning principles used. Sadirman (2010) states that a teaching and learning process is said to be good if the process can generate effective learning activities. Also, several suggestions from the validator were included, such as critical thinking features that were used so that the module developed could meet the participants' thinking levels.

A good module should be following the level of thinking and ability of students which in the results of this validation get very valid criteria. According to Afriadi *et al.* (2013), the formulation of the module must be following the ability level of students or the ability of the user (Self-Contained) so that users can easily understand the module material.

Modules that are interesting/fun can have a positive influence on students, especially on students' reading interest in learning. According to Sari (2017), the module is declared to have met the technical requirements because the use of writing,

concept maps, images, and colors as well as the appearance of the module is appropriate and attractive. The display of teaching materials plays a role in increasing the motivation of students and their interest in learning material and avoiding boredom in the modules presented (Kurniawati, 2012).

4. Format Aspects

The format aspect consists of 7 validity indicators. Six indicators get very valid results. Module indicators equipped with systematic get a percentage of 100%, systematic numbering is clear with a percentage of 95.83%, indicators for the type and size of fonts (letters) that deserve a percentage of 100%, material indicators for each relevant activity get a percentage of 87.50%, indicators for each part are identified obtained a percentage of 95.83%, and the bibliography indicator following the reference of the written book obtained a percentage of 97.92%. One indicator of the format aspect obtains valid results, namely the text indicator and balanced illustrations with a percentage of 75.00%.

The developed modules are equipped with systematic use of the modules and are arranged in a clear format. This developed module is divided into 4 CHAPTERS, in each CHAPTER consisting of several Sub-Chapters which are given with a clear numbering or type of number according to its level. The module numbering systematics is clearly stated with the validation results obtaining very valid criteria. According to Sari *et al.* (2017), a clear module arrangement format can make it easier for students to understand the subject matter. According to Afriadi *et al.* (2013) module is a learning tool or learning tool that is designed as attractive as possible and systematically useful to achieve the expected competencies according to the level of complexity.

The next assessment looks at the size and type of writing in the biology module, this aims to improve the quality of the module content in presenting material that is easy to understand and helps students using the biology module. Things that are also considered are the clarity of the appearance of the images and attractive colors of the module which will provoke students to use the biology module being developed. The type and size of the fonts used in this module are adjusted so that they are easy to read so that the criteria are very valid. According to Sari *et al.* (2017), the type and size of letters for print-based media must be comfortable and easy to read.

Validation of indicators of the relevance of material and activities in the developed module shows the relationship between the material and

learning and evaluation activities. This is also supported by the results of the validation on the identified indicators of the module section which get very valid results. According to Afriadi *et al* (2013), the description of the contents/materials of the module is arranged systematically and formulated in a clear learning unit starting from the presentation of the material, instructions for use, and evaluation tools.

In addition to the material aspects described earlier, appropriate supporting references are also needed to strengthen the description of the material, then to avoid plagiarism, each reference is included in the bibliography. The material is summarized from various relevant sources. The module developed has met the criteria for conformity with references. According to Prastowo (2012) reference is one of the main parts of the module. According to Kartika *et al.* (2020) reference to a valid module must obtain valid criteria. According to Setiawati *et al.* (2017) Bibliography contained in the module, the design presents references or lists of references used in module preparation.

The module developed obtains valid criteria on balanced indicators of text and illustrations because the proportion of image and text sizes on a page is made precisely. According to Sari *et al.* (2017), a module that uses the appropriate type and size of writing, images, colors, and appearance of the module can attract students to read it. According to Falah *et al.* (2019) choosing an appropriate image will provide meaning that is following the content of the lesson, besides choosing the type of writing and its layout, too much writing will reduce the attractive impression on the cover. In this regard, in this study, the choice of colors, pictures, and writing are very concerned.

The validity regarding the format of things that must be assessed is the systematicity of the module, which is the focus of the assessment in this validity including module indicators equipped with module systematics, clear numbering systems, balanced text, and illustrations, appropriate type and size of fonts (letters), material for each relevant activity, each section identified, bibliography following the book reference written. This is done with the aim that the developed module format gives an attractive impression to students. Things to pay attention to in some of the validator's suggestions are the clarity of the image display and attractive colors and the appearance of the cover must be added with some interesting features, which will lure students to use the developed module. According to Yazid (2016) validation is very important to meet the criteria for a good teaching material format. This opinion is in line

with this research, it is proven that after validating the module format it looks better.

5. Aspects of Module Assessment in Supporting Innovation and Improvement of Teaching and Learning

The module assessment aspect in supporting innovation and improving teaching and learning activities consists of four validity indicators. Three indicators of obtaining very valid results include the module in supporting the implementation of the teaching and learning process independently with a percentage of 89.58%, the module provides convenience in developing students' critical thinking with a percentage of 81.25%, and the module provides convenience in making learning evaluation questions 91.67%. One indicator of obtaining valid results is that the module can invite further students' curiosity with a percentage of 77.08%.

The developed module can support the implementation of the teaching and learning process independently because it is arranged according to systematic, clear indicators, the material according to the level of the reader, and is equipped with instructions for independent learning activities. According to Daryanto (2015) & Khoirudin (2019), a module equipped with user-friendly instructions for use can be used by students for independent learning. According to Widyaningrum *et al* (2013) the implication of Vygotsky's theory explains that modules are not only used as independent teaching materials but also integrated into learning through discussions and experiments conducted in small groups. Teachers can also be involved by assisting in the form of instructions, warnings, encouragement in the early stages of learning then students take responsibility independently.

One of the objectives of developing the module is to get optimal results for learning conditions for each individual, with this it is hoped that students can begin to learn independently using modules that have been developed, because with the procedures and instructions for using modules and delivery of material that starts to be easy to understand to be able to invite students to think critically so that it is easier to understand the material, and image presentation.

Indicators able to invite the curiosity of students have valid criteria. This is evidenced by the presence of critical thinking features. By displaying the critical thinking feature, several sentences of questions from the concept are presented. Amelia *et al.*, (2019) explained that the presence of critical thinking features can foster students' curiosity and can train science process

skills and obtain information. Also, it is suggested by experts that the material, worksheets, and practice questions in the module feature critical thinking skills. According to Khoirudin (2019), a module equipped with questions can increase the thinking power of students. Also, modules equipped with field activity instructions can improve the skills students have.



Figure 1 Front Cover of the Biology Module

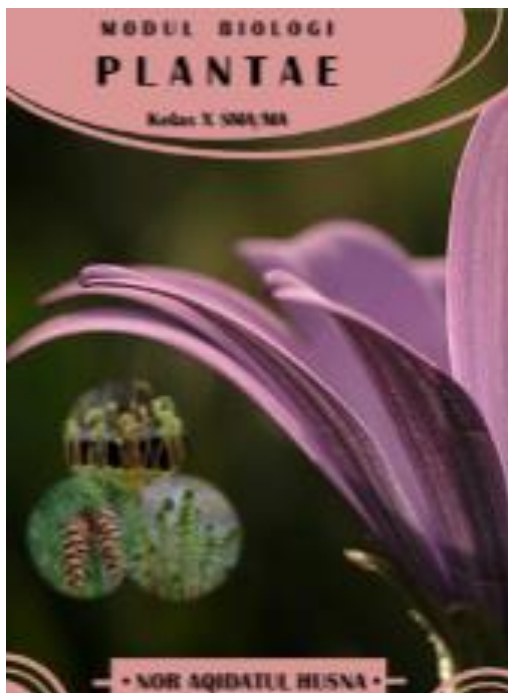


Figure 2 Cover Plantae CHAPTER I



Figure 3 Cover Animalia CHAPTER II



Figure 4 Ecosystem Cover CHAPTER III

The importance of validity in developing teaching materials has been proven by research conducted by Sari (2017) that the validity of the reproductive system learning module is included in the very valid category in terms of didactic, construct, and technical aspects, the validation

results obtained from the validators obtained an average value of 3.70 in the very valid category. Also, Afriadi *et al.* (2013) have produced a module developed on the human reproductive system material that is quite valid with a module validity value of 78.70%.



Figure 5 Environmental Cover CHAPTER IV

Overall input from experts is that the compilation of a biology module based on critical thinking skills is very valid when viewed from these five aspects. The final draft of the biology module based on the results of expert validation can be seen in Figure 1 which is the front cover image of the module, Figure 2 is the cover of Chapter I on the Plantae material, Figure 3 is the cover of Chapter II on Animalia material, Figure 4 is the cover of Chapter III on Ecosystem material, Figure 5 is the cover chapter IV Environmental material.

D. Conclusion

The biology learning module based on critical thinking skills that were developed as a whole obtained very valid criteria. Material aspects are divided into four indicators, including two very valid indicators and two valid indicators. The language aspect is divided into four indicators, the four indicators are very valid. The presentation aspect is divided into four indicators, including one very valid indicator and three valid indicators. The format aspect is divided into seven indicators, including six very valid indicators and one valid indicator. Finally, the aspect of module assessment

in supporting innovation and improvement of teaching and learning activities is divided into four indicators, including three very valid indicators and one valid indicator.

SUGGESTION:

This research is still limited to the validity test, to obtain information on the feasibility of this module, it is necessary to continue with the practicality test by the user teacher and the effectiveness test obtained from the user students.

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