



The Development of Biology E-Module Based on Unity of Sciences and Science Literacy as Teaching Materials for Students in Senior High School

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ABSTRACT

The pre-research analysis shows that the challenges of the 21st century students in scientific literacy skills and character building are in the low level. Therefore, researchers carry out development biology *e-module* based on *Unity of Sciences* and scientific literacy as teaching material for students in senior high school. The purpose of the research is to generate and evaluate feasibility of biology *e-module*. This type of research used *Research and Development (R&D)* and the development model used ADDIE models but it is restricted to *develop* (development) stage. Data collection used the method of observation, interviews, scientific literacy tests and questionnaires. The research was conducted at MAN 1 Semarang City with a sample of 30 students in class XI MIPA 4. We found that our biology *e-module* have a great potential module through the data we collected. The percentage results obtained from material experts was 97.2%, teaching materials experts was 75%, *Unity of Sciences* experts was 87.5%, scientific literacy experts was 86.1% and practitioners was 91.6%. Besides that, *e-module* included in the very decent category, in the range of 87.5% based on the readability test by the students. Thus, the results of this research show that the *e-module* developed can increase insight into the integration of Islamic values and train students' scientific literacy skills based on grade 11 biology material.

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INTRODUCTION

Advances in science and technology are developing rapidly in the 21st century or in the digital era. This is because various fields of life such as education in Indonesia have experienced developments in technology and information using electronic devices. 21st-century learning requires human resources who have skills and knowledge in guiding teaching and learning activities (Nisa et al., 2020). The teacher's challenge in 21st-century

learning is that they must be competent to apply various methods, models, and learning media that are in line with the digital era. In addition, teachers are also required to have a better understanding of science and technology so it is necessary to increase the competence and creativity of teachers (Febrianti, 2021). Therefore, teachers must be able to adapt to 21st-century developments so that effective learning is realized both from the aspects of attitude, knowledge, and student skills (Rahayu et al., 2022).

The challenge of 21st-century learning is not only to focus on student's academic abilities but also on students' attitudes and morals (Rini et al., 2021). 21st century learning is facilitated by the use of digital media which can facilitate the search for information as a learning resource. However, the misuse of digital media has become one of the factors causing the fading of student character values. This is marked by a crisis of morals and spirituality of students so character education is needed by instilling religious values. Character education can be formed by understanding human behavior about God, fellow humans, and nature through a learning process (Suraji & Sastrodiharjo, 2021).

Education with an understanding of religion and science is an effort to minimize the negative effects of technological developments. The integration of Islamic values and science is referred to the *Unity of Sciences* (UoS). Integration of UoS can be applied in the learning process through the spiritualization of modern science, the humanization of religious knowledge, and the revitalization of *local wisdom* (Syukur & Junaedi, 2017). 21st-century learning by applying *Unity of Sciences* aims so that students and teachers can improve their attitude toward spirituality and good character values. Thus, learning in the 21st century is expected to be able to realize human resources who are broad-minded by trying to instill Islamic values adapted to the times. Islam has placed education as a guideline for life and as part of human immortality (Khasanah et al., 2018). Education-related lifelong *education* is interpreted as "life long education" so that it has a philosophical meaning which means immortality. This shows that education can apply UoS as an integration of Islamic values (Fanani, 2015). Education in 21st-century learning considers

it necessary that students and teachers have broad knowledge and insight because the 21st century is a form of community development from time to time (Yusuf, 2018).

Education in the 21st century is expected to increase the value of students' knowledge and skills by utilizing various kinds of technology. However, most students still use technology to play social media and games *online* rather than seeking information or knowledge to train scientific literacy (Risidiana, 2022). This shows that students lack interest in seeking information and scientific knowledge so scientific literacy skills need to be improved to understand scientific concepts (Reis et al., 2014). 21st-century learning students should have a culture of being scientific, rational, and critical thinking, and produce appropriate solutions to solve everyday life problems. Education must be able to equip students to have scientific literacy skills so that they can increase their knowledge, skills, and learning outcomes to be more optimal (Eren et al., 2020). States that there are still many students who are low in scientific literacy skills. This is influenced by many things such as the selection of methods, learning media that are less precise and still tend to be conventional, and inadequate learning facilities (Sutrisna, 2021). In addition, research according to Fuadi et al., (2020), states that the factors causing students' low literacy skills are related to PISA results (*The Programme for International Student Assessment*) such as the selection of textbooks that are not appropriate, misconceptions, learning that is not appropriate to every day or contextual problems, low habit of reading science and a non-conducive learning climate. Thus, learning solutions are needed to train students' scientific literacy abilities (Susilo, Agus., 2016).

The solution to train scientific literacy skills can be through teaching materials or media as learning resources so they can encourage students to learn that is relevant to the applicable curriculum (Fuadi et al., 2020). The availability of teaching materials in schools is very important as a support for the quality level of education in the 21st century. The 21st-century teaching materials are marked by a transformation in terms of presentation from conventional to electronic such as *e-module*. *e-module* is an electronic teaching material containing learning materials developed in a planned manner with the integration of interactive features and various information that can be connected to internet access. Besides, *e-module* features can also be added-flipbook so it is more practical, efficient, and interactive (Ricu Sidiq & Najuah, 2020). Teachers must be able to develop teaching materials as study guides in a meaningful and broad-minded manner to train students' scientific literacy skills.

Teaching materials function in strengthening interactions between students and the environment, encouraging student experience and knowledge, and building a more meaningful learning process (Nisa et al., 2020). It is necessary to pay attention to the compatibility of teaching materials with the subject matter because good teaching materials must be adapted to competency standards and basic competencies, have aspects of knowledge and skills, and be practical and systematic so that it makes it easier for students to understand subject matter such as biology subjects. One of the materials considered to be a challenge for teachers and students is biology material for class XI even the semester. This is because the material for class XI biology is quite complex and related to one another, so it needs to be studied in the teaching materials being developed. Based on Raida's research

(2018), states that the material considered difficult by teachers and students in biology material is material for class XI even semester because material concepts tend to be difficult to understand, there is a lot of material and teachers find it difficult to present material due to limited time allocation (Raida, 2018).

The results of the interview with the Semarang City MAN 1 biology teacher, stated that biology material that is suitable for scientific literacy training is material that has a lot of theory and can be applied contextually such as the respiratory, excretion and coordination systems. The selection of this material is also adjusted to the needs of students. In addition, the results of observation and analysis of the documentation show that the biology teaching materials used are modules and LKS (student worksheets), but none of these teaching materials relate to Unity of Sciences and have not focused on scientific literacy by 21st-century developments. The results of the scientific literacy test for class XI MIPA 4 of 30 students showed that scientific literacy skills were still low. The results of the scientific literacy test of 18 questions, students were only able to answer the questions correctly as much as 48.3% for indicator 1 (identifying valid scientific opinions), indicator 2 (evaluating the validity of sources) as much as 63.3%, indicator 3 (performing effective literature searches) as much as 20%, indicator 4 (understanding the elements in the research design) as much as 41.6%, indicator 5 (making accurate graphs from data) as much as 20%, indicator 6 (reading and interpreting the graphical representation of data) as much as 58.6%, indicator 7 (solving problems using quantitative skills, including basic statistics) as much as 38.3%, indicator 8 (understanding and interpreting basic statistics) as much as 13.3% and indicator 9 (doing inferences,

predictions and drawing conclusions based on quantitative data) as much as 26.6% (Gormally et al., 2012). Therefore, it is necessary to develop oriented teaching materials UoS, and students' scientific literacy. The difference in teaching materials developed by teachers is that the form of presentation is still conventional (printed), the material is not yet oriented UoS, and supporting information is still lacking. While the teaching materials to be designed by researchers are electronic-based, oriented forms of presentation, information supporting scientific literacy and practice questions, and trial tests.

METHOD

This research was conducted over 3 months, namely February, March and April 2023 at MAN 1 Semarang City. The type of research used is *Research and Development* (R&D) to design products and evaluate the feasibility of a particular product. This study uses the ADDIE development model developed by Dick and Carry in 1996 (Cahyadi, 2019). The ADDIE development model has 5 (five) stages, including analysis, design, development, implementation, and evaluation (Branch, 2009). The reason we chose to use the ADDIE development model was because the work stages were systematic and each stage was evaluated and revised from the stages it went through. In addition, this model is aligned with the needs and conditions of learning so that the product is expected to be feasible and easy to use in this research (Silaban, 2021).

Material on *e-module* has been designed in even semester including the respiratory system, excretory system, and coordination system. This research was conducted only up to the stages of development. In addition, researchers develop teaching material *e-*

module based on *Unity of Sciences* by only including 2 (two) implementation strategies *Unity of Sciences* namely the spiritualization of modern science namely biology, and revitalization of *local wisdom*.

Modules are validated by teaching material validators, material validators, Unity of Sciences validators, and scientific literacy validators. The next module was tested for readability on class XI MIPA 4 students with a total of 30 students. The results of validation and readability tests were analyzed using quantitative descriptive and qualitative descriptive. The level of product feasibility can be seen from the results of the analysis of the questionnaire data, both the validation test questionnaire and the readability test which have been filled in in the form of a Likert scale which will be further processed (Yuliarmi, 2019). Data in the form of a Likert scale can be categorized in Table 1 as follows.

Table 1. Likert Scale Criteria

No	Category	Scale	Score
1	Strongly agree	SS	4
2	Agree	S	3
3	Disagree	S	2
4	Strongly disagree	STS	1

(Yuliarmi, 2019)

The scores obtained are then processed descriptively using the following formula. The score obtained after the data is processed, then the eligibility criteria for teaching materials are classified *e-module* in Table 2 as follows.

Table 2. Product Development Eligibility Criteria

No	Category	Score
1	Very unfit and unusable	0% - 20%
2	Unfit and unusable	21% - 40 %
3	Decent enough and usable with major revisions	41% - 60%
4	Decent and usable with partial revisions	61% - 80%
5	Very decent and usable with minor revisions	81% - 100 %

(Sugiyono, 2018)

Table 2 shows that *e-module* that has been designed is included in the category suitable for use as teaching materials if it obtains a percentage value from the validation process $\geq 61\%$. Thus, the product is considered feasible so that it can be used as teaching material (Shofwunnada, 2017).

RESULTS AND DISCUSSION

A. Initial Product Development Result

The resulting products are e-module-oriented biology *unity of sciences* and scientific literacy as teaching material for class XI SMA/MA students. Biology *e-module* was developed based on the results of the analysis of students' needs in learning activities. This biology *e-module* is developed to deepen student character by associating *Unity of Sciences* and train students' scientific literacy skills. Besides, *e-module* learning can be used as teaching materials that are practical, interactive, and broad-minded according to 21st-century learning. The development model is using the ADDIE development model. The product development stage consists of the following steps.

1. Analyze

The analysis phase is carried out to analyze potential problems to be resolved or solved with the right solution (Cahyadi, 2019). The performance analysis stage was carried out by researchers through observations at schools and interviews with teachers. The results of the performance analysis show that the process of learning activities requires alternative biology teaching materials that are appropriate to 21st-century learning and instill student character education. The results of the interview with the biology teacher, explained that the

teaching materials used in class XI were in the form of printed modules, worksheets, and power points so they still used printed or conventional teaching materials. He also explained that there were no teaching materials that were equipped with *Unity of Sciences* to instill character in students.

In addition, the needs analysis stage was carried out by researchers through interviews with students and students' scientific literacy tests. The results of the needs analysis on the questionnaire show that students are more interested and increase their curiosity when using digital teaching materials. Students also have difficulty with complex biology material so that biology *e-module* uses the subject matter of senior high school biology class XI in even semester covering material on the respiratory system, excretory system, and coordination system. In addition, students' scientific literacy is low as shown in the results of scientific literacy tests, so it is necessary to develop alternative biology teaching materials for class XI that can train students' scientific literacy skills.

2. Design

The design stage is the stage of compiling and organizing *draft* the product is in the form of content or learning material. It involves the design of concepts and product planning strategies based on the results of problem analysis. The purpose of the design phase is to develop a draft product design *e-module* to meet the learning needs of both students and teachers (Najuah et al., 2020). *E-module* designed using the following media:

- 1) *Microsoft word* 2010 is used to organize the layout of the text and set the appearance of the design *e-module* developed, see on Figure 1.

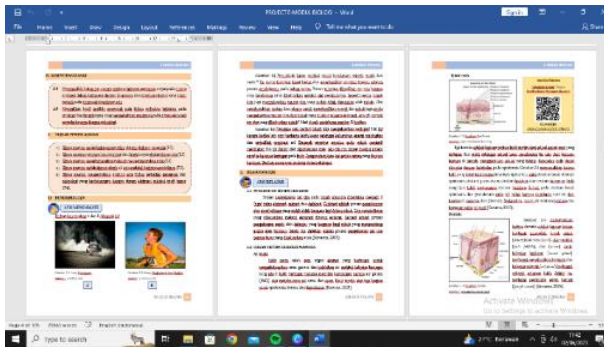


Figure 1. Creating E-module content using Microsoft Word 2010

- 2) Application *flip pdf professional* used to change the draft *e-module* the pdf version into digital form and can add learning video features and interactive quizzes that are adapted to biology material, see on Figure 2.

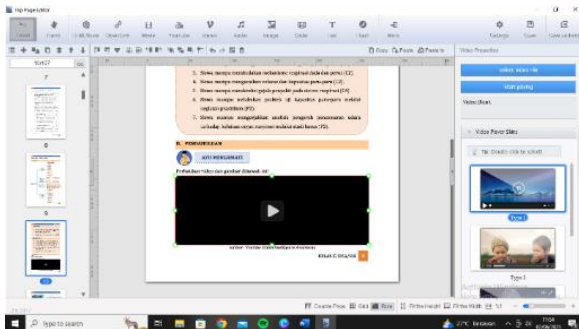


Figure 2. Creating E-modules with Flip Pdf Professional

- 3) Adobe *photoshop* used to design the front cover and back cover *e-module*.

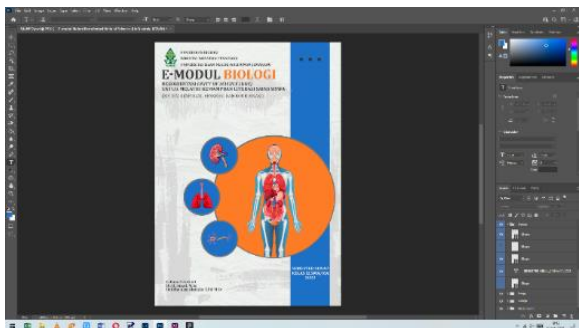


Figure 3. Creating an E-module cover using Adobe Photoshop

- 4) Canva was used to add an animated image icon feature to add a touch of interest to your *e-module* developed.



Figure 4. Creating animated icons with Canva

Link modul biology : <https://online.flipbuilder.com/whcgn/camz/>

3. Development

The development stage (*develop*) is carried out by developing the results of a design or design to be tested for validation to obtain an assessment in the form of suggestions or comments from the validator to produce mode according to needs analysis. The validation function is so that the designed product can be feasible and valid to be used in the learning process so that the validation results are used as a form of improvement mode that has been planned (Najuah et al., 2020).

Systematics *e-module* Biology is arranged based on a component systematic *e-module* that has been compiled, then validated. *E-module* which is planned needs to be validated by material experts, teaching materials expert *e-module*, *Unity of Sciences* expert, scientific literacy experts, and expert practitioners (teachers). Validation *e-module* refers to an instrument that has been designed which aims to validate the product before being tested for readability by students (Mukholifah et al., 2020). The validation assessment data is in the form of a Likert scale result with a score of 1 to 4 which is then analyzed in the form of a percentage (%). In addition, the validity test also obtained suggestions and input that were used to improve the design mode so that it is suitable

for use as teaching material (Budiastuti, 2021). The following are the results of the validator's assessment:

a. Validation by Teaching Materials Expert

Validation by e-module teaching material experts aims to provide an evaluation of the components or content of e-modules that are adjusted to the criteria of teaching materials so that students can understand teaching materials properly. The results of the validation of teaching material experts are in the form of scoring score data on the systematics of product presentation, product

use *e-module*, product displays e-module, language, and product quality e-module by the instruments in the form of aspects and indicators that have been designed (Budiastuti, 2021). In addition to scores, researchers also received suggestions and input for improvement and refinement of *e-module-developed* biology. Expert validator is an expert in the field of teaching materials *e-module*. Data from the validation results of teaching material experts can be seen in Table 3 below.

Table 3. Validation by Teaching Materials Expert

No	Assesment Aspect	Assessment			
		$\sum X$	$\sum Xi$	%	Category
1	Product presentation	15	24	79	Worth it
2	Product use	6	8	75	Worth it
3	Product display	16	20	80	Worth it
5	Languages	12	16	75	Worth it
6	Product quality	14	16	87.5	Very Worth it
Total		63	84	75	Worth it

Based on the results of the assessment *e-module* by teaching material experts in Table 3 shows that validity *e-module* get a total average score of 75%, so it is categorized that *e-module* oriented biology *Unity of Sciences* and scientific literacy as teaching material for class XI MIPA SMA/MA students is suitable for use in the next test, namely the students' readability test.

b. Validation by *Unity of Sciences* expert

Validation by members of the Unity of Sciences on the teaching materials of the e-module aims to unify biology as science and religion. Validation results in the form of assessment score data *Unity of Sciences* and local wisdom on *e-module*. The UoS

validation instrument is adjusted to aspects and indicators that have been designed such as UoS presentation, accuracy UoS, description of UoS, correlation of UoS with society and UoS suitability (Naja et al., 2021). In addition to scores, researchers also obtained suggestions and input for improvement or revision as a form of improvement to *e-module*. Expert validator assessing validation is lecturer who is an expert in the field *Unity of Sciences*. Expert validation data *Unity of Sciences* listed in Table 4 below.

Table 4. Validation by *Unity of Sciences* expert

No	Assesment Aspect	Assesment			
		ΣX	ΣXi	%	Category
1	Presentation UoS	16	16	100	Very Worth it
2	Accuracy Uos	8	8	100	Very Worth it
3	Explanation UoS	20	20	100	Very Worth it
4	Corelation UoS with Society	17	20	85	Very Worth it
5	Suitability UoS	16	16	100	Very Worth it
Total		77	80	87.5	Very Worth it

Based on the results of the assessment *e-module* by members *Unity of Sciences* in Table 4 shows that the validity of the expert *Unity of Sciences* with Islamic values and local wisdom on *e-module* get a total average value - the overall average is 87.5% so it is categorized *e-module* very feasible to do the readability test by students.

c. Validation by Material Expert

Validation by material experts is intended to explain the form of the content of teaching materials and to determine the level of feasibility of *e-module* teaching materials developed from material aspects. The results of the material expert validation are in the form of scoring score data on the systematic

completeness of the material, the accuracy of the material, the updating of the material, the supporting material, the presentation of products and language according to the instruments in the form of aspects and indicators that have been compiled (Fallensky, 2021). In addition to scores, researchers also obtained suggestions and input for improvement or revision as a form of improvement to *e-module*. The expert validator who assessed the validation of biological material was an expert in the field of biological material. Material expert validation results data are listed in Table 5 below.

Table 5. Validation by Material Expert

No	Assesment Aspect	Assesment			
		ΣX	ΣXi	%	Category
1	Material equipment	16	16	100	Very worth it
2	Material accuracy	19	20	95	Very worth it
3	Material up to date	15	15	100	Very worth it
4	Supporting material	25	25	100	Very worth it
5	Product presentation	14	16	87.5	Very worth it
6	Languages	16	16	100	Very worth it
Total		105	108	97.2	Very worth it

Based on the assessment data *e-module* by material experts in Table 5 shows that the validity of the material presented in *e-module* obtaining a total average value of 97.2% so that it is categorized that *e-module* oriented biology *Unity of Sciences* and scientific literacy as teaching material for

class XI SMA/MA students is very suitable for use in the next test, namely the student readability test.

d. Validation by Scientific Literacy Expert

Validation by scientific literacy experts aims to train students' scientific literacy skills so they can identify facts or scientific evidence from various information and analyze the use of scientific inquiry methods as well as organize and interpret quantitative data and scientific information. The results of the validation of scientific literacy experts are in the form of scoring score data on the systematic aspect of understanding the inquiry method which leads to scientific knowledge and organizes, analyzes and

interprets quantitative data and scientific information, each of which consists of indicators of scientific literacy relevant to the instruments that have been designed (Sutrisna, 2021). In addition to scores, researchers also obtained suggestions and input for improvement or revision as a form of improvement to *e-module* that has been designed. The expert validator was lecturer who is an expert in the field of scientific literacy. Data from scientific literacy expert validation results are listed in Table 6 below.

Table 6. Validation by Scientific Literacy Expert

No	Assesment Aspect	Assessment			
		$\sum X$	$\sum Xi$	%	Category
1	Understand inquiry method the lead to scientific knowledge	12	16	75	Worth it
2	Organize, analyzed and interpret quantatif data and information	19	20	95	Very worth it
3	Total	31	36	86.1	Very worth it

Based on the assessment data *e-module* by scientific literacy experts in Table 6 shows that the validity of the material presented in *e-module* obtaining a total average value of 86.1% so that it is categorized that *e-module* oriented biology *Unity of Sciences* and scientific literacy as teaching material for class XI SMA/MA students is very suitable for the next test, namely the students' readability test.

e. Results of Practitioners' Responses (Biology Teachers)

The results of responses from biology teachers as expert practitioners are also needed in development *e-module*. Data from the responses of expert practitioners are listed in Table 7 below.

Table 7. Practitioner Responses (Biology Teacher)

No	Assesment Aspect	Assessment			
		$\sum X$	$\sum Xi$	%	Category
1	Product presentasion	17	20	85	Very worth it
2	Product use	7	8	87.5	Very worth it
3	Product display	19	20	95	Very worth it
4	Languages	12	12	100	Very worth it
5	Material equipment	10	12	83.3	Very worth it
6	Supporting material	11	12	91.6	Very worth it
7	Orientation <i>UoS</i>	12	12	100	Very worth it
Total		88	96	91.6	Very worth it

Based on the results of an assessment by expert practitioners *e-module* in Table 7 shows that the feasibility assessment *e-module* obtained a total average value of 91.6%. Therefore, *e-module* oriented biology *Unity of Sciences* and scientific literacy as teaching material for class XI SMA/MA students is very suitable for use in the next test, namely the student readability test.

The large-scale readability test in this study consisted of 30 students of MAN 1 Semarang City who were taken from class XI

MIPA 4. Product legibility test *e-module* by students using a sampling technique, namely technique *purposive sampling*. The product readability test as a collection of student response data is carried out in a random way *offline* through an assessment sheet in the form of a questionnaire that must be filled out by students as respondents to *e-module* that have been designed by researchers. Readability test results *e-module* broad-scale students in the field test can be seen in Table 8 below.

Table 8. Readability Test Results *e-module* by Students

No	Assessment		Assessment		
	Aspect	ΣX	ΣXi	%	Category
1	Material	498	600	83	Very worth it
2	Language	304	360	84.4	Very worth it
3	Desain	530	600	88.5	Very worth it
4	Use	768	840	91.4	Very worth it
Total		2100	2400	87.5	Very worth it

The results of student responses to *e-module* in Table 8 shows that *e-module* get the total value of the overall average of 87.5% means *e-module* oriented biology *Unity of Sciences* and scientific literacy as teaching material for class XI SMA/MA students is very suitable for use adapted to even semester biology material, namely material on the respiratory system, excretory system and coordination system.

CONCLUSION

Results from the development of biology *e-module* oriented *Unity of Sciences* and scientific literacy as teaching material for class XI SMA/MA students can be concluded that the validation stage by experts from teaching materials experts *e-module* was 75%, *Unity of Sciences* expert was 87.5%, material experts was 97.2%, scientific literacy experts was 86.1%, and

practitioner experts was 91.6%. Meanwhile, through a large-scale legibility test by class XI MIPA 4 students, the overall result was 87.5%. Thus, the development *e-module* Biology is included in the very feasible category based on the results of validity tests and large-scale readability trials by students of class XI MIPA 4 at MAN 1 Semarang City.

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