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Research Article

Developing e-laboratory instructions based on the unity of sciences paradigm in producing tempeh

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Abstract: Hands-on activities experienced many obstacles during the Covid-19 pandemic. So, students' skills in the laboratory were also affected. In addition, the inculcation of Islamic values in learning needs more attention in religion-based schools. The study aimed to develop a design of e-laboratory instruction based on the unity of sciences paradigm on biotechnology material (producing tempeh) and prove its feasibility. This study uses the ADDIE model by Dick and Carey (1996). The data collection techniques are interviews, questionnaires, and documentation. The subjects of this study were students of twelfth graders in science class in SMA Hasyim Asy'ari Pekalongan, Central Java. The validation results from material and media experts show that e-laboratory instruction is very eligible, 91.81% and 85.38%. While the integration expert validators state that design is very high (86.67%). The biology teacher's response reached 85.71% (very high). The result of the pilot test is 85.41%, categorized as very high. The e-laboratory instruction based on the unity of sciences paradigm in producing tempeh is suitable for learning.

Keywords: e-laboratory instruction; producing tempeh; unity of sciences

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1. Introduction

The COVID-19 pandemic has both positive and negative impacts on education. The positive impact is technological development can provide learning with a virtual meeting (Dania & Griffin, 2021; Ristanto et al., 2020; Varisa & Fikri, 2022; Xie et al., 2019). Technology makes it possible to conduct the learning process without being limited by space and time. So that the learning process is not only carried out in the classroom. However, hands-on activities experienced many obstacles during the Covid-19 pandemic. Teachers and students cannot conduct a hands-on activity in the laboratory. Laboratory activities aim to support students' implementing their scientific methods skills. With hands-on activities, students can practice thinking with scientific principles or learn to practice work procedures based on scientific methods (Cigrik & Ozkan, 2015; Darrah et al., 2014; Hendriyani & Novi, 2020; Snapir et al., 2022). According to Daba et al. (2016), laboratory activities can achieve three learning objectives, namely cognitive skills (understanding theory so that it can be understood and applied to real life), affective skills (learning to appreciate their field, working together, preparing activities independently), and psychomotor skills (learning to use and practicing a laboratory tool).

Based on the interview results with one of the teachers in SMA Hasyim Asy'ari Pekalongan, there were obstacles during laboratory activities during the pandemic. One of them is the time allotment reduction. Students carry out practical activities at home in a simple way. The instructions still use the guidelines contained in worksheets, textbooks, and notes from the teacher. There are no specific practical instructions, especially in biotechnology material. The material is related to everyday life, such as conventional biotechnology. In biotechnology material, students are expected to experience the application of biotechnology principles to produce a product, such as tempeh, oncom, tauco, yogurt, soy sauce, and others. SMA Hasyim Asy'ari Pekalongan is a school that has a skill excellence and religious excellence program. One of the skill excellence programs is catering. It becomes necessary to practice making food innovations related to fermentation. The concept will integrate the skill and understanding of the production process of conventional biotechnology products. The students can understand the fermentation process in the manufacture of conventional biotechnology products. One example of a conventional biotechnology product is tempeh.

Tempe is a fermented food made from soybeans (Aslindawaty & Cembes, 2022; Ristia et al., 2014). On the other hand, sometimes soybean prices are high because the supplies are limited. Alternative materials are needed to make tempeh. One of the ingredients that can be used to make tempeh is mung beans. Mung beans are abundant and stable in Indonesia, so it is easy to find. In addition, the nutritional content of mung beans is also good. Mung beans can be used to make tempeh. It will produce a food product that contains lots of protein and antioxidants (Maryam, 2015). Therefore, the practical implementation of making mung bean tempeh can be used as an alternative and introduce students to practical innovations with different food ingredients.

In addition, online learning also decreases student character building (Intania & Sutama, 2020; Muna et al., 2021; Purba et al., 2021). Previously, character-building embed indirectly in the learning process in class. Activities that support character-building can also happen directly and intensively. So, teachers can measure the achievement of the student's character. For example, in several Islamic schools, it is necessary to instill religious values in their learning. However, the lack of teaching materials as a reference related to the unity of sciences makes it not optimally implemented.

One of the Islamic state universities in Indonesia, UIN Walisongo, developed a paradigm called the unity of sciences. This paradigm is required when applied to religious-based schools such as SMA Hasyim Asy'ari Pekalongan. The unity of the sciences paradigm is a view that reveals that all the knowledge on earth is an inseparable unity. So that religious knowledge and science go hand in hand and do not clash with each other (Tsuwaibah, 2014). One of the methods used is the integration of Islam with the verses of the Qur'an.

Therefore, the solution is to develop an e-laboratory instruction based on the unity of sciences. E-laboratory instruction is a technology-based teaching material. Previous research by Susatyo and Damanik (2021) explained that this e-laboratory instruction helps students carry out practicums and provides information on practicum materials. E-laboratory instruction assists teachers in overcoming time limitations in learning so that students can plan practicums outside of learning hours according to the directions contained in teaching materials.

The developed e-laboratory instruction in this study integrates Islam and contains biotechnology material, especially in practicum procedures for producing mung bean tempeh. Religious knowledge and general science need to be applied to religious-based schools to create a balance of students' character. The development of this e-laboratory instruction uses the unity of sciences strategy, including the spiritualization of modern sciences, the humanization of Islamic sciences, and the revitalization of local wisdom. The development of e-laboratory instruction based on the unity of sciences can meet the needs of schools. The study aimed to develop and test the validity of e-laboratory instruction products based on the unity of sciences as biotechnology teaching materials for twelfth graders in science class.

2. Materials and Methods

This research and development used the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model developed by Dick and Carry (1996). The research stage reaches the development stage because the purpose of this research is to design and produce teaching materials that are feasible to implement based on the validator's expert assessment. Detailed explanations for the stages of analysis, design, and development are as follows.

2.1 Analysis Stage (A)

The analysis stage consists of needs analysis, analysis of student characteristics, and analysis of the curriculum. The needs analysis is carried out by interviewing biology teachers and distributing questionnaires to students. Then the student feature analysis is carried out by providing a package that includes learning methods, learning devices used, and the desired characteristics of the contents of the material. The curriculum analysis stage examines the basic competencies. Then formulates learning indicators following the curriculum used at SMA Hasyim Asy'ari Pekalongan namely Curriculum 2013.

2.2 Design Stage (D)

This stage consists of four steps. The first step is compiling biotechnology material based on core competencies and basic competencies in the Curriculum 2013. Then, choosing the software to design products using Microsoft Word 2019. The third step is planning design rules for layout, appearance, font shape, font size, and others. The display of e-laboratory instructions will be developed with an electronic flipbook display using the Flip PDF Professional software and packaged in the form of an application on a smartphone using the Website 2 APK Builder software which can access by the link.

2.3 Development Stage (D)

The activity at this stage is to realize the design results. The resulting product is a feasibility assessment by validator experts. Data collection techniques include interview techniques, documentation, and questionnaires. The sample selection used a saturated sampling technique because the total population was less than 30. The number of samples was 23 students of twelfth graders in the science class of SMA Hasyim Asy'ari Pekalongan. Interviews were conducted with biology teachers. While the documentation techniques by taking photos and videos of mung beans tempeh experiments and research questionnaire results. The questionnaire technique was used to test product validation by experts and to measure the product feasibility by biology teachers and students. The rating scale uses a rating scale of 5 (Table 1).

Table 1. The criteria of assessment score

Category	Score
Very good	5
Good	4
Moderate	3
Not good	2
Very not good	1

The feasibility percentage of the developed product using the Formula 1.

$$\text{Percentage} = \frac{A}{B} \times 100\% \quad (1)$$

Descriptions:
A = The scores obtained
B = Maximum scores

After getting the results of the eligibility percentage, then the results are converted into the validity criteria presented in Table 2.

Table 2. The validity criteria of assessment score

Percentage (%)	Qualification	Validity Category
81-100	Very good	Very high
61-80	Good	High
41-60	Moderate	Moderate
21-40	Not good	Low
<20	Poor	Very Low

3. Results

3.1 Analysis Stage (A)

The questionnaire results to measure the characteristics of students show that the learning process during the pandemic was carried out with direct intrusion. Practical activities are not carried out during online learning. Students only observe videos related to hands-on activity materials. The devices used by students are cell phones for online learning activities, and only a few use laptops. Teaching materials that students want are interesting and not monotonous. Teaching materials should also be accessible using students' cell phones.

Furthermore, the curriculum analysis stage is carried out by examining basic competencies and formulating the learning indicators. The basic competency used is KD 4.10, namely, students are expected to be able to experiment with conventional biotechnology principles to produce a product, such as tempeh, oncom, tauco, yogurt, soy sauce, and others. The competency indicator is that students can practice experiments on making tempeh from mung beans to implement biotechnology principles.

3.2 Design Stage (D)

The e-laboratory instruction development design consists of a front cover (cover), title page, preface, table of contents, general instructions, biotechnology material, practicum worksheets, unity of sciences, project development, report writing systematics, and bibliography. The e-laboratory instruction is equipped with features to make it easier for readers to use this product. This product was compiled and designed using Microsoft Word 2019 software and packaged in the form of a flipbook display application that can be accessed on cell phones.

3.3 Development Stage (D)

The result of development stage is described in some figures. Figure 1 shows the front page of the developed e-laboratory instruction, and the samples of materials. Then, the feasibility data were obtained from the validators, biology teachers, and students. Suggestions and input from the validator and the biology teacher's responses form the basis for product improvement to suit the school's needs. Figure 2 shows the feasibility assessment by the validators and the biology teacher.

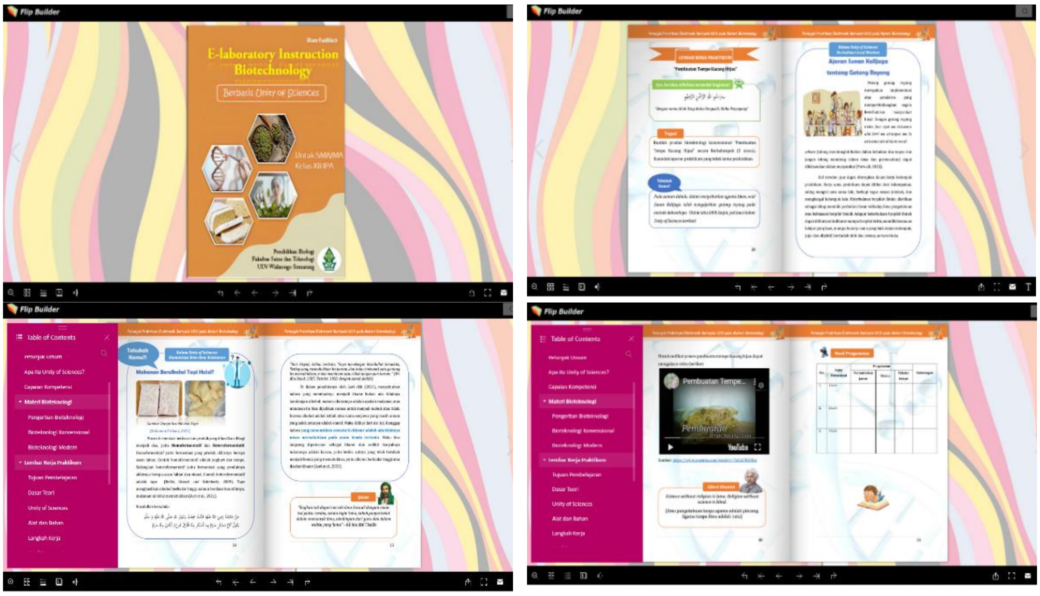

Figure 1. The sample page of the developed e-laboratory instruction.

The feasibility assessment by the validators and the biology teacher's responses showed that the e-laboratory instruction based on the unity of sciences showed a very high category (Figure 2). The developed e-laboratory instruction can be used as teaching material by revising the suggested parts of the expert validators and biology teachers. The material expert assessment shows a percentage of 91.81%. It means the material and information contained in the e-laboratory instruction are very valid (very high category). The assessed aspects by material experts include material feasibility, content feasibility, and language. The e-laboratory instruction feasibility assessment by a media expert validator based on the unity of science is 85.38% (very high category). The product is feasible in terms of media and design. Aspects of media assessment include aspects of usability, programming aspects, and feasibility aspects. The percentage of eligibility by integration experts is 86.71%, a very high category. The aspects assessed are aspects of the accuracy and clarity of the relationship between the verses of the Qur'an and biotechnology material. Then the feasibility test from the biology teacher gets a percentage of 85.71% (very high category). The measured aspects are the material relevance, the concept of e-laboratory instruction, and the product's presentation. Suggestions and input on e-laboratory instruction products from experts and biology teachers are used to improve and perfect the product.

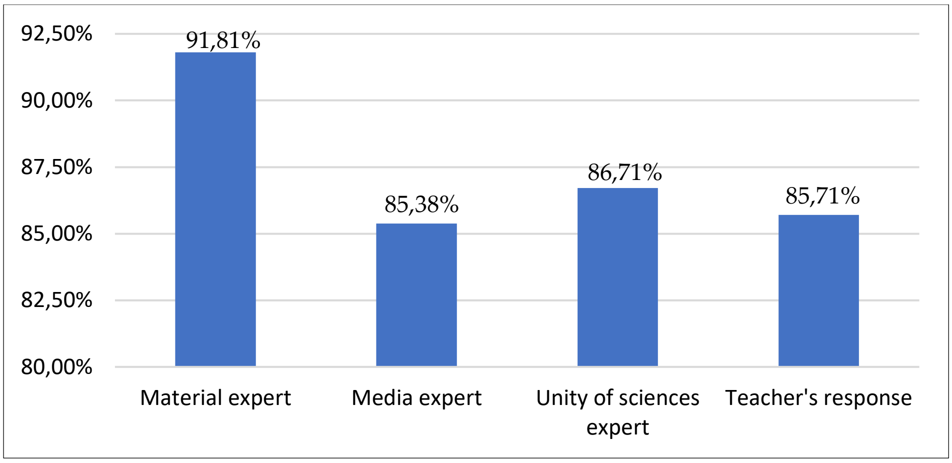

Figure 2. The result of feasibility assessment by the validators and the biology teacher.

Furthermore, the e-laboratory instruction feasibility test for 23 twelfth graders of science class in SMA Hasyim Asy'ari Pekalongan shows the results shown in Figure 3. The results show that the average percentage of all aspects gets a score of 85.41% (very good category). The aspects assessed include presentation aspects, material aspects, language aspects, and aspects of Islamic integration.

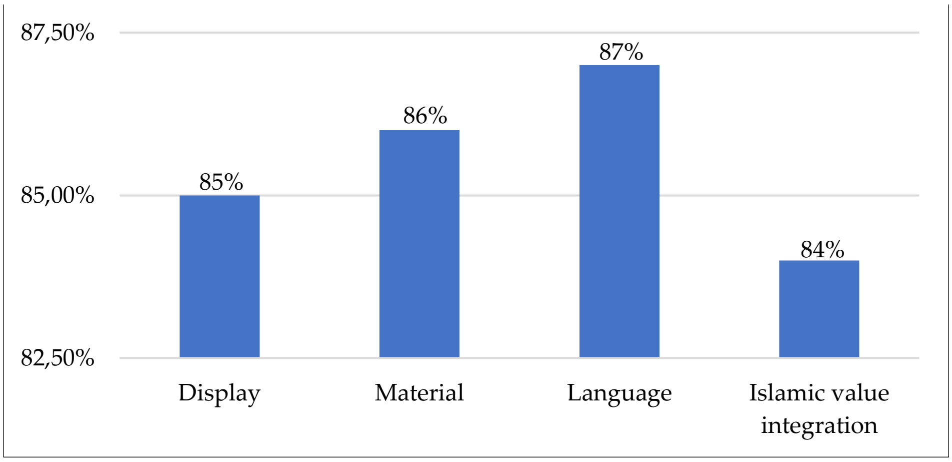

Figure 3. The result of feasibility assessment by students' response.

4. Discussion

E-laboratory instruction is a technology-based teaching material. It is appropriate for education 4.0 that technology plays a principal role in learning. Education 4.0 are influenced by the industrial revolution 4.0 (Agolla, 2018; Sadikin et al., 2020). Its characteristics in the learning process make more use of digital technology (cyber system). The e-laboratory instruction developed in this study contains biotechnology material and laboratory procedures for making mung bean tempeh that integrates with Islamic values. Concerning this research, e-laboratory instruction can help educators overcome time limitations in learning. In line with Susatyo and Damanik (2021) that state e-laboratory instruction assists students in carrying out and providing information about practicum material, and students can plan practicums outside of learning hours according to the instructions contained in the teaching materials.

The e-laboratory instruction display is developed with a flipbook view that produces using Flip PDF Professional software. This software can convert an ordinary pdf into a flip book on the gadget. Making learning media with a flipbook display can add features such as text, images, audio, and video to become a unit in presentation (Afwan et al., 2020; Damayanti, 2018; Hayati et al., 2015). Through videos inserted in teaching materials, biotechnology learning activities can help students learn online and independently (Ijaz et al., 2017; Pyatt & Sims, 2012; Wu et al., 2019). This research got a very decent response from the respondents. The results are strengthened by Aftiani et al. (2021) that developed a professional PDF-based flip book. The flip book received good responses from students because it could increase learning independence and students' interest in learning. Similar research related to flipbook teaching materials such as digital flipbook media by integrating local history material (Afwan et al., 2020), digital flipbook immunogenic, flipbook e-modules in basic vocational programming (Ristanto et al., 2020), the animal tissue system flipbook (Damayanti, 2018) has proven effective and suitable for use as teaching material.

The result of feasibility assessment by students' response showed that the e-laboratory instruction is very good category. In line with research conducted by Susatyo and Damanik (2021) that developed e-laboratory instruction based on blended learning can get very good responses from students and be practically used as teaching materials. Puspita et al. (2021) research also argues that developing an e-module chemistry practicum using Canva Design received a positive response from students during the pandemic. Another study by Sakdiah and Fatmi (2021) stated that the e-module virtual physics practicum was feasible to support the learning process.

The product developed in this research is based on the unity of sciences. It is UIN Walisongo Semarang paradigm. This paradigm is very important if it is applied in religious-based schools such as SMA Hasyim Asy'ari Pekalongan. The development of e-laboratory instruction complemented by the unity of sciences strategy has received a very appropriate response from integration experts. One of the strategies of the unity of sciences is the spiritualization of modern sciences. Spiritualization is an attempt to provide a basis for divine and ethical values to secular sciences to ensure that all sciences are oriented towards improving the sustainability of human and natural life. This strategy is carried out by integrating the verses of the Qur'an (Fanani, 2015). According to Hidayat et al. (2020), integration is two different things that combine in one place, but each science is taught according to its methodology. Learning equipped with the unity of sciences aims to form the character of students who have faith and increase piety through the phenomenon that proves the power of Allah SWT. Referring to the research of Junaedi and Wijaya (2021), learning based on the unity of sciences will produce modern scientists who are religious and not anti-local culture. According to Nirwana and Fitriyana (2018) integration of the unity of sciences can make learning more meaningful. Similar research was conducted by Rohmah (2019), which developed practicum instructions with unity of sciences insights on equilibrium material that received a good response from students, and the resulting teaching materials aimed to avoid dichotomy of science.

The second strategy of unity of sciences is local wisdom revitalization. The local wisdom revitalization strategy consists of efforts to remain firm on the noble teachings of local culture and its development to strengthen national character (Fanani, 2015). The local wisdom revitalization strategy incorporates Sunan Kalijaga's teachings about cooperation and Sunan Ampel's teachings about the prohibition of "Molimo". The principle of cooperation (*gotong royong*) is an implementation in society. It can be applied in laboratory activities such as practicum group work. The teachings of "Molimo" relate to the prohibition of not doing gambling, adultery, drunkenness, drugs, and thieves.

Furthermore, the strategy for the unity of sciences paradigm is the humanization of Islamic sciences. What is meant by humanization is reconstructing Islamic sciences so that they can touch and provide solutions to the real problems of human life. The humanization strategy includes all efforts to integrate universal Islamic values with modern science to improve the quality of life and human civilization (Fanani, 2015). The strategy for humanizing Islamic sciences included in this e-laboratory instruction is by inserting issues regarding conventional biotechnology products containing alcohol.

Then, in the e-laboratory instruction product, there are practical guidelines on making mung bean tempeh so that students can make innovations in conventional biotechnology products. The selection of mung beans in the manufacture of tempeh is due to the scarcity of soybeans due to the rarely found and the price. So, we need an alternative to making tempeh with other beans, one of which is mung beans. The availability of mung beans is very abundant and stable in Indonesia, so they are easy to find. In addition, the nutritional content of mung beans is also good (Maryam, 2015). According to Long (2013), mung beans can be used to make tempeh. This will produce a food product that contains lots of protein and antioxidants. The antioxidant content of mung beans includes flavonoids, triterpenoids, and saponins, while mung bean tempeh contains flavonoids, triterpenoids, saponins, and polyphenols. The antioxidant content of mung bean tempeh is better than mung bean.

Mung bean tempeh is a functional food that has a positive impact if consumed on the human body because it can ward off free radicals. Mung bean tempeh contains lower fat than soy tempeh. It is based on research by Radiati (2016) that soybean tempeh contains as much as 17.7 grams of fat, while mung bean tempeh contains 1.2 grams of fat, so mung bean tempeh is very suitable for consumption by people who avoid consuming high fat. Products developed in teaching materials do not only use mung beans in practicum activities but there are also development projects. Project development is the development of previous practicum experiments. The purpose of this development is to find out the differences between fermented tempeh from various other ingredients such as jackfruit seeds. So, the e-laboratory instruction based on the unity of sciences paradigm in producing tempeh is suitable for use in the learning process.

5. Conclusions

The research and development result of e-laboratory instructions based on the unity of sciences paradigm in producing tempeh is feasible to use for twelfth graders in science class. The validation results from material and media experts show that e-laboratory instruction is very eligible, 91.81% and 85.38%. While the integration expert validators state that design is very high (86.67%). The biology teacher's response reached 85.71% (very high). The result of the pilot test is 85.41%, categorized as very high. The e-laboratory instruction based on the unity of sciences paradigm in producing tempeh is suitable for learning.

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