



Validity and Practicality of Sangiran Site-Based Virtual Laboratory Learning Media on Evolutionary Materials to Empower Science Literacy

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Abstract: The validity and practicality of the media are a condition before it can be widely piloted. This research aims to find out the validity and practicality of the Evolution Virtual Laboratory Learning Media, which was developed based on the artefacts of the Sangiran Site to empower science literacy of students. The media validity test using expert judgment involved two expert validators, and two high school biology teachers. While the media practicality test involved 20 grade 12th students. The instrument used was a validity questionnaire consisting of 9 items (material experts), 18 items (media experts), and 13 items (practitioners). Questionnaire instruments to students as many as 16 items. All questionnaires use the Likert Scale. The test results showed material experts rated 86.80%, media experts 84.6%, education practitioners 84.30%, and students by 79.00%. Based on the validity and practicality of the Sangiran Site-based Evolution virtual laboratory learning media is declared valid and practical, so it can be used for effectiveness testing.

Keywords: Virtual laboratory; Sangiran sites; Evolution; Science literacy

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Introduction

One of the abilities that students need in the 21st century is science literacy skills (McFarlane, 2013; Partnership for 21st Century Skills, 2008; Rosyadah Mukti et al., 2019; Turiman et al., 2012). Science literacy has been widely studied and researched from various aspects (Lawless & Brown, 2015; O'toole et al., 2020; Shaffer et al., 2019; Sulistiyowati et al., 2018; Suwono, 2016). Science literacy or often called "scientific literacy" is the application of scientific knowledge in identifying problems, describing scientific phenomena, and formulating conclusions based on evidence collected from the surrounding environment (PISA, 2019). The application of scientific knowledge to scientific literacy

can be achieved by applying conceptual understanding of science, natural phenomena, and interpreting reports on problems. (Kok-Sing Tang & Danielson, 2018).

Students' science literacy skills are considered low in some research (Jufrida et al., 2019; Lieskovský & Sunyík, 2022). Aspects of competence in science literacy are considered need to be improved is the ability to develop inquiry questions, and experiments that are built new at the verification stage of textbooks have not been on the understanding of the learners themselves (Merta et al., 2020). Learners also have difficulties in presenting scientific methods and problem solving based on facts and evidences (Osborne, 2014). Skills related to identifying elements of research studies, identifying their strengths and weaknesses, justifying

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conclusions based on quantitative data and understanding the basics of statistics, learners have not been able to achieve these indicators (Čipková et al., 2019).

A person who has the ability to read science is able to know concepts, understand, explain, communicate and apply science in solving problems (Li & Guo, 2021; Sinatra et al., 2014). In other words, overall science literacy skills have engaged students to play an active role in different areas of life (Rokhmah et al., 2017).

One of biological learning topics that are closely related to the literacy ability of science is evolution (Olander, 2013). Students' understanding of the concepts of evolution is part of the science literacy expected in 21st century learning (Crowell & Schunn, 2016). In evolution topics, science literacy can be interpreted as students understand the concepts of evolution and are able to apply them to investigate natural cases or facts and in problem solving (Van Dijk, 2014).

Evolution is a topic in the biological sciences that explains the changes in organisms that occur gradually to adapt to time and the environment (Henuhili, 2012). The theory of evolution examines the mechanisms of change that occur in living things. In addition, the theory of evolution undergoes changes according to the times and technological developments. Topic of Evolution often gives rise to pros and cons. To date, controversy over the theory of evolution has mainly concerned with doubts about the truth of evolution (Schulteis, 2010). The topic of Evolution consists of complex and abstract categories, so they are not easily understood, and students often experience misunderstandings or misconceptions, causing concepts. Evolution is more difficult than learning about other topics (Cheng et al., 2015; Heddy & Sinatra, 2013; Kampourakis & Zogza, 2009). Complex and abstract concepts of evolution require assistance in the form of learning media innovations so that students are able to master the science literacy (Kinshuk et al., 2016).

Improvements to the understanding of evolution concepts can be done by learning innovation through inquiry models and problem-solving strategies as well as visualization of the complexity and validity of concepts of evolution (Kinshuk et al., 2016). Inquiry learning models and problem-solving strategies can be applied to teaching media in the form of virtual laboratories (Hermansyah et al., 2019). And visualization of the complexity and integrity of matter can be accommodated using concrete learning resources in the form of fossil artifacts, one of which is collected by the Sangiran Site Museum.

Sangiran Site is one of the museums that can facilitate the understanding of scientific concepts that stimulate interest and motivation in learning about evolution (Falchetti, 2012). Sangiran Site is in Saragen Regency, Central Java, Indonesia. The use of Sangiran

Site as a learning resource has also been explored a lot, but most study are about prehistoric or for history education purposes (Jati et al., 2020; Purnomo et al., 2018), earth or soil structure on high school science subjects (Liskasari et al., 2018).

The topic of Evolution has been taught by high school biology teachers in Indonesia based on the high school Biology textbooks. Evolution Material is displayed in chapter 7 of 12th grade high school Biology, discussing subtopics of evolution theory, types of evolution, evolution mechanisms, speciation, evolution history, clues to the existence of evolution, theory of the origin of life, and theory of evolution tendencies.

The evolution learning media that has been studied is an ESQ-based evolution learning module (Darussyamsu et al., 2019). However, media in the form of virtual labs with the use of fossil collections and biological evolution information at Sangiran Sites do not yet exist.

Based on preliminary studies, it is known that teachers in schools around the Sangiran Museum have not utilized the potential of the museum as an optimal learning source. From the results of observations and interviews to teachers and students at schools around Sangiran, it is known that there are two teachers who have used the Sangiran Museum for direct learning, i.e., by visiting the Sangiran Museum. However, this activity cannot be carried out during the pandemic.

The lack of utilization of Sangiran Site as a source of evolution learning is suspected due to the lack of understanding on how set up the sources into the content of teaching and learning process. The results of the preliminary study also showed that Sangiran Museum has the potential to become a virtual laboratory to study the concept of evolution and is assumed to be able to increase students' interest.

Learning media is a tool in the learning process (Hartini et al., 2017). Learning media as a tool must be innovative and keep up with the times (Mukhadis et al., 2021). Currently, one of the abilities demanded is science literacy (McFarlane, 2013). Thus, learning media are needed that supposed to be able to accommodate the empowerment of science literacy (Fauville et al., 2015). One learning medium that can accommodate the empowerment of science literacy is a virtual laboratory (Alneyadi, 2019).

Based on this fact, in 2021 the Research Team has developed a virtual laboratory learning media for Sangiran Site artifact-based Evolution materials to empower students' science literacy skills. But the virtual media lab needs to be tested for feasibility before being widely piloted. The validity of virtual laboratories in this study includes the validity of media and materials experts. The validity of a development media can be determined based on validation activities by experts (Kwon et al., 2013).

This article will present the results of the Sangiran Site-based Virtual Evolution Lab media validity and practicality test assessed by expert validators, teacher practitioners and students.

Method

The feasibility assessment of Virtual Laboratory Evolution was carried out by the expert judgement assessment method, which was rated by two experts, namely material or content, and media experts. While the practicality test of media use in schools was assessed by 2 biology teachers and 20 of 12th grade high school students who were belong to Public High School No.1 Sumber Lawang, Sragen, a school which locates near the Sangiran Site.

The instruments used were the questionnaire in the form of questions or statements using the Likert Scale 1-5. The aspects assessed in the validity test are displayed in Table 1 and 2.

Table 1. Aspects of the Media Expert Validity

Aspects
Display
Programming
Pay attention to the code of ethics and copyright

Table 2. Aspects of the Material Expert Validity

Aspects
Eligibility of content
Eligibility of presentation
Language eligibility
Feasibility of quality of instructions

The Practicality Test in this study was run by teachers and students in response to the development of virtual laboratory learning media. The aspects assessed in the practicality test can be noticed in Table 3 and 4.

Table 3. Aspects of Teachers' Practicality Test

Aspects
Content
Graphics and Media
Media Conformity with Materials

Table 4. Aspects of Students' Practicality Test

Aspects
Media
Interest
Usage and durability

The data obtained from the results of the validity test and the practicality test were analyzed using the following steps:

$$P = \frac{\sum Xi}{\sum X} \times 100\% \tag{1}$$

- P : Percentage of ratings
- $\sum Xi$: Score given by an expert validator
- $\sum X$: Maximum Score

Table 5. Likert Scale Interpretation

Score (%)	Category
0 - 25	Poor
26 - 50	Not Good
51 - 75	Good
76 - 100	Very Good

(Riduwan, 2010)

A former overview of the virtual media of the Evolution lab is shown in Figure 1.



Figure 1. Front Page

The content which covered in the virtual laboratory are six topics, namely: Changes in the Environment and Ancient Human Life; Differences in the Skulls of Early Humans; Early Humans in Indonesia; Comparison of Humans and Chimpanzees; Fossil Excavation; and Sangiran Fossil Collection.

Results and Discussion

The Validity of the Media

Media expert validity test is consisting of three aspects, namely appearance, programming, and code of ethics and copyright. The assessor was one media expert validator (Table 6).

Table 6. Media Validation Result

Aspect	Percentage (%)	Category
Display	94	Very Good
Programming	80	Very Good
Ethics Code and Copyright	80	Very Good

The display of the virtual lab was rated 94%, 80% in the programming aspect, and 80% in the code of ethics and copyright. The overall average of the measured aspects reached 84.6% with the category very good.

In the aspect of the display of the virtual lab, the expert gave suggestions on revising the order of the menu, which should be changed from top to bottom or set the menu in one line from right to left. The image given cannot be understood easily because there is no correct order of the pictures and there is no capture for species name embedded with the image.

In the programming aspect, in all of the pages of the virtual lab, the "home" icon was not available. It is suggested to add the "home" button. The virtual lab, then was revised according to the advice and input from the expert, and the media then was declared fit for use (Figure 2).



Figure 2. The early pages of the Virtual lab

Media validity test is declared valid after reviewing by the media experts (Badu et al., 2021). Media experts are people who have the capacity in the field of media development. Media development includes display, programming, and code of conduct. The developed virtual laboratory media has been declared valid based on all three indicators.

The Validity of the Content

The content or material is the main component in teaching (Giguère et al., 2020). Materials in teaching are input for students to build knowledge and practice certain skills. (Gess-Newsome, 2015). The material in this virtual laboratory is compiled based on Sangiran Site to facilitate visualization of evolution. The virtual laboratory on Evolution is expected to empower students' science literacy.

The validity aspects of the content are the feasibility of content, the presentation, language, and the quality of instructions. The validator was a lecturer majoring in Evolution. The result of the review is presented in Table 7.

Table 7. Material Validity Test Results.

Aspect	Percentage (%)	Category
Content	90	Very Good
Serving	86.60	Very Good
Language	84	Very Good
Intruction Quality	86.60	Very Good

Based on the results of the validity test above, the material listed in the Sangiran Site-based virtual laboratory learning media scored 90% on the feasibility aspect of content, 86.6% on the aspect of presentation, 84% on the aspect of language, and 86.6% on the quality instruction. The overall average of the measured aspects reached 86.80% with excellent categories.

Some input and advice from material experts related to content on the media, the use of images must be trusted, use interesting types of writing so as not to be monotonous and enter the material as follows *Australopithecus aferensis*: more quadrupedal, feet walk than bipedal. *Homo habilis upwards* runs bipedal, so the function of the hand is no longer to run → evolved for various functions, one of which is using tools and making tools (not just using tools but making. Usually in the place where the fossils will be found also artifacts that are tools used made to support survival (for hunting, foraging etc.). *Homo erectus* as its name implies erect=standing upright. So they are able to walk upright. Evidence suggests they migrated from Africa to several places in Europe and Asia (as found in Sangiran). The virtual lab has been revised based on the comments from the assessor (Figure 3).



Figure 3. One page of the content

The validator of the content had declared that the content of the virtual lab is very good in all aspects. The presentation of the virtual laboratory of Evolution has met the criteria and is feasible based on media and material validation tests with several revisions. The small field trial phase is carried out to obtain the practicality value of virtual laboratory learning media based on Sangiran Site.

Teacher Practicality Test Results

One of the goals of development research is to provide scientific benefits based on its practicality (Parviainen et al., 2017). The practicality of learning media is the ease of users in operating learning media (Putra, 2021). Practicality is tested by users; users of learning media directly are teachers and students.

The teachers practicality test consists of three aspects, namely content, graphics and media, and the suitability of the media with the material. The results of the teacher's practicality test can be seen in Table 8.

Table 8. Teacher Practicality Test Results

Aspect	Percentage (%)	Category
Content	90	Very Good
Graphics and Media	75	Good
Compatibility Material	88	Very Good

Based on the results of the teacher practicality test above, the test response to teachers reached 90% in the content aspect, 75% in the graphic and media aspects, and 88% in the aspect of media conformity with the material. The overall average of the measured aspects reached 84.3% with the category very well.

Regarding the content, there was a suggestion from teachers, i.e., add fossil images which are available in the Sangiran Site. The additional images will help students to know more about evolution evidence.

The student practicality test consists of three aspects, namely media, interest, use and endurance. The student practicality test was conducted by a small group of students who piloted a virtual laboratory. The results of the practicality test is presented in Table 9.

Table 9. Student Practicality Test Results

Aspect	Percentage (%)	Category
Media	81	Very Good
Interest	72	Good
Wearability and durability	84	Very Good

Based on the results of the student practicality test, the response of small field trials scored 81% in the media aspect, 72% in the interest aspect, and 84% in the aspect of use and endurance. The overall average of the measured aspects reached 79% with excellent categories.

The results of the validity and practicality tests show an excellent category average. Therefore, it is declared valid and practically used for follow-up research.

Conclusion

The validation test of Sangiran Site-based virtual laboratory has shown that the media are feasible to be tested in large scale groups. The validation scores are on average 84.6% for media validity and 86.8% for material validity. The practicality test ran for teachers with an average of 84.3% and for students by 79%. Based on the validity and practicality tests that researchers have conducted, Sangiran Site-based virtual laboratory learning media to empower students' science literacy skills are declared valid and practical, so that they can be used for advanced research.

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