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Analysis Validity and Readability of STEM-Based Virtual Laboratory Lab Gene Learning Media on Modern Biotechnology Materials to Improve Science Literacy of High School Students

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Abstract

The Learning based on the Merdeka Belajar Curriculum allows students to be more independent in choosing their learning resources. Modern biotechnology practicum is often not carried out due to expensive tools and materials, and is usually incomplete. Teachers tend to only focus on the application of conventional biotechnology, and do not explore modern biotechnology. In addition, the science literacy skills of students in schools are still low, and there is no virtual laboratory learning media that can be used by students to improve understanding of modern biotechnology concepts for understanding biological technology innovation in CP phase F. This study aims to test the validity and openness test of STEM-based Lab Gene virtual laboratory learning media on modern biotechnology material. Data analysis was conducted to measure the validity and readability of the learning media. The results showed that the validity value of Lab Gene was declared valid with a value of 90.10% or including a very high category (very valid) by material experts and 83.75% or including a very high category (very valid) by media experts. Meanwhile, the results of media readability (rumpang analysis) by 9 students at SMAN 1 Sumber obtained 89.03% with a very good category. Based on the research results, it is known that the STEM-based Lab Gene virtual laboratory is said to be valid and has good readability. Lab Gene virtual laboratory learning media is feasible to be implemented in schools to improve students' science literacy.

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INTRODUCTION

Online learning is no longer a new phenomenon, as it has been progressively adopted by schools and universities around the world (Gretenet et al., 2024). In Indonesia, learning based on the Independent Learning Curriculum has been widely implemented in schools. This learning-based learning allows students to be more independent in choosing their learning resources. Independent Curriculum-based learning has Learning Outcomes that must be achieved by students from phase A to phase F (Kemendikbudristek, 2022). This research will focus on phase F of the biology subject with material on Biological Technology Innovation. Biology material contains many abstract concepts. Facts and concepts can be obtained through the process of observation, experimentation, and rational analysis (Yuniarti et al., 2012). One of the abstract biological materials is biotechnology, especially modern biotechnology.

Understanding of a material can be obtained through practicum activities. Practical activities can help students to understand and solve problems, understand concepts, and understand the material more deeply. This concept understanding is obtained through a scientific process. (Lang, 2012; Makransky et al., 2016; Muchson et al., 2019). Experimentation is an important part of the scientific method that relies on collecting measurable evidence and accurate data (Seifan et al., 2020).

In the application of modern biotechnology materials in schools, teachers do not explore modern biotechnology materials and sometimes only focus on the application and implementation of conventional biotechnology practicum. The choice of learning media, lack of mastery of the material, unavailability of laboratory tools and materials, as well as time and human resources in the implementation of practicum, are problems that must be resolved.

Preliminary studies conducted at MA Sains Salman As-Salam and SMAN 1 Sumber found that laboratory equipment to support modern biotechnology practicum is still very minimal. Lack of space, expensive costs, staff to help with the practicum, and narrow practicum time make biotechnology practicum not done at school. In addition, students' learning patterns have changed. Students choose to use cell phones which are ideal for learning. Learning media that uses cell phones, laptops or other computer devices, and can facilitate and overcome the problems of practicum implementation is virtual laboratory learning media. Teachers should innovate to create virtual laboratory learning media that can be used as alternative learning (Jamilah 2013).

The limitations of scientific learning in the conventional teaching and learning process can be overcome by implementing a virtual laboratory (Potkonjak et al., 2016). Experiments using virtual laboratories are intuitive and take less time (Zhao et al., 2019). However, in contrast to research conducted by Srinivasa et al., 2020, it shows that students can spend more time in virtual laboratory tutorials (Srinivasa et al., 2020).

Science literacy can be used as a reference for scientific thinking or when solving problems and making decisions (Ardianto & Rubini, 2016). Increasing students' science literacy can be supported by technology-based learning and STEM (Science, Technology, Engineering, and Mathematics). Students' interest in learning can be further enhanced if all four aspects of STEM are applied together (Kelley & Knowles, 2016). Students can improve their science literacy skills and be able to solve STEM problems through independent experimentation in a virtual laboratory (Sari et al., 2021). In the virtual laboratory, the development of students' hands on skills is reduced, but indirectly students' minds on skills are increased (Wisudawati & Sulistyorini, 2014). Students' creativity and social skills in groups can be formed through STEM learning (Zuryanty et al. 2020).

The development of virtual learning media for Lab Gene laboratory was made using Articulate Storyline 3 software. Articulate Storyline 3 is a presentation and communication maker (Kumbara & Rodliyah, 2021). The menu contained in Articulate Storyline 3 is almost the same as Microsoft Power Point, coupled with other completeness such as creating applications, flash, and games questions or short quizzes (Rianto, 2020).

There are 3 standard assessment criteria that must be met to get a quality product, namely the product or learning media must have valid, practical, and effective criteria (Yuliana, 2017). The truth of a conclusion obtained from research results, which are given treatment, then assessed based on the correct sequence of research data collection, samples and research subjects, and the population of the samples used, must all be measured so that the validity of the research is very high (Murti, 2011). This study aims to test the validity and readability of STEM-based Lab Gene virtual laboratory learning media to improve the science literacy of high school students.

METHOD

The research subjects used were class XI students in two schools including SMAN 1 Sumber in Cirebon and MAN 1 Cirebon City. Students were sampled as much as 1 class each, namely XI MIPA 5 SMAN 1 Sumber with 34 students and XI MIPA 1 MAN 1 Cirebon City with 30 students. School and class samples were randomly selected using purposive sampling method. Data collection techniques used are interviews, questionnaires, observations, and tests. Changes in students' science literacy skills were measured based on pretest-posttest results and student practicum report project assignments.

The calculation of the score of validation results by material experts and virtual laboratory learning media Lab Gene is calculated using the V-Aiken's formula in equation 1 (Azwar, 2012) as follows:

$V: (\sum(ri-lo))/([n(c-1)])$.....(1)

Description:

V : Aiken's V formula
r: the number given by the assessor
lo : the lowest validity assessment number
c : the highest validity assessment number
n : number of experts & practitioners who conduct the assessment
i : integer from 1,2,3 to n

The validity test criteria for the Lab Gene virtual laboratory learning media have the following percentage ranges:

Table 1. Criteria for Validity Score

Score Range	Criteria
$81.25\% < V \leq 100\%$	Very valid
$62.5\% < V \leq 81.25\%$	Valid
$43.75\% < V \leq 62.5\%$	Less valid
$25\% < V \leq 43.75\%$	Not valid

(Sugiyono, 2016)

The calculation of the readability analysis of the Lab Gene virtual laboratory learning media on a small scale trial is calculated using the formula in Equation 2 (Sugiyono, 2016) as follows:

$P = F/N \times 100\%$.....(2)

Description:

P : percentage score
F : number of scores obtained
N : maximum number of scores

Qualitative learning media readability test criteria have a percentage range according to (Sugiyono, 2016) can be seen in Table 2 as follows:

Table 2. Criteria for Readability Score

Score Range	Criteria
$81.25\% < P \leq 100\%$	Very good
$62.5\% < P \leq 81.25\%$	Good
$43.75\% < P \leq 62.5\%$	Less good
$25\% < P \leq 43.75\%$	Not good

(Sugiyono, 2016)

RESULT AND DISCUSSION

The validity of the virtual laboratory learning media Lab Gene is obtained from the results of validation by material experts and media experts. Material and media validation was carried out by Postgraduate Lecturers Faculty of Mathematics and natural sciences Universitas Negeri Semarang and High School Teachers. The scoring technique used is using a Likert scale of 1-5. The validity results will be used for further media development, so that the media is better and valid before being implemented in schools, suggestions and comments from material experts and media experts are used for the next stage of revision. The results of the validity test by material experts can be seen in Table 3 as follows:

Table 3. Material Expert Validity Test Results

Aspects	n (c-1)	V	Criteria
Additional Information Aspects	84	89%	Very high
Aspects of Information Presentation	36	94%	Very high
Aspects of Material Deepening	72	89%	Very high
Total	192	90%	Very high

The virtual laboratory learning media Lab Gene obtained a material validity value with a very high category (very valid) in each aspect of the assessment. The validity value of the material expert is 90% (very high/very valid). The validity test by this material expert was reviewed based on three aspects, namely aspects of additional information, aspects of information presentation, and aspects of material deepening. Based on the three aspects tested by the material experts, the presentation aspect of the information received the highest score of 94% with a very high or very valid category, while the lowest score was in the

aspect of deepening the material with a score of 89% included in the very high or very valid category.

Furthermore, this STEM-based virtual laboratory Lab Gene learning media was validated by media experts. This media expert assessment refers to appearance, functionality, language, and media access. The results of media validation by media experts are presented in Table 4 as follows:

Table 4. Media Expert Validity Test Results

Aspects	n (c-1)	V	Criteria
Additional Information Aspects	24	92%	Very high
Aspects of User Attitude Considerations	36	78%	Very high
Aspects of User Relationship with the Program	60	82%	Very high
Navigation Aspect	36	72%	High
Pedagogical Aspects	60	92%	Very high
Aspects of Invisible Features	24	84%	Very high
Total	240	84%	Very high

Based on the results of the validity analysis, media experts have a total validity value of 84% with a very high category (very valid). The highest aspect assessment of 92% with a very high category (very valid) is in the aspect of additional information and pedagogy aspects. The lowest aspect value is in the navigation aspect of 72% with a high category. In the future, the development of this learning media must be improved from the navigation aspect. The display of the STEM-based Lab Gene virtual laboratory learning media is as follows.

Figure 1. STEM-based Virtual Laboratory Lab Gene Learning Media

After conducting a validity test of the Lab Gene virtual laboratory learning media, this study also tested the media on a small scale (rumpang analysis) to determine the readability of the media that had been made before being implemented in a large-scale trial. There were only 9 students who conducted the small-scale trial, consisting of students with the highest score of 3 students; students with the average class score of 3 students; and students with the lowest score of 3 students. The 9 students were asked to give their responses to the virtual laboratory learning media developed.

The data from the media readability test were analyzed using the formula in Equation 2. The results of the media readability analysis (rumpang analysis) in the small-scale trial are presented in Table 5 as follows.

Table 5. Media Readability Test Results

Aspects	Number of Questions	Score (%)	Criteria
Learning media	3	88.15	Very good
Material	10	89.78	Very good
Benefits	3	87.41	Very good
Average		89.03	Very good

Based on the results of the media readability analysis on small-scale trials in terms of all aspects including aspects of learning media, material and benefits, obtained a score with an average of 89.03% which included a very good category. The highest score is obtained in the material aspect which is 89.78%, so it is known that the readability of the media in this material aspect is very good. Students are able to understand the material in the learning media. So, after revisions and readability tests, the virtual laboratory learning media Lab Gene can be implemented on a large scale in both schools, namely at SMAN 1 Sumber and MAN 1 Cirebon City.

STEM-based Lab Gene virtual laboratory learning media must go through validation testing to determine the feasibility of the media that has been made. learning products such as virtual laboratory learning media that are in accordance with the needs will be better if adjusted by paying attention to suggestions and comments from experts (Sugiyono, 2016; Hidayati, 2016). Learning materials and media must adjust the assessment of validity experts in terms of material and media (Dzikro & Dwiningsih, 2021). The learning phase, learning outcomes, flow of learning objec-

tives, and indicators of learning achievement in the Lab Gene virtual laboratory learning media have been adjusted to the regulations in the Merdeka Belajar Curriculum independent learning guidelines.

This STEM-based Lab Gene virtual laboratory learning media is a visual-based media so that the material or engineering demonstrations in the practicum can be well visualized and more interesting. In the Lab Gene virtual laboratory learning media, the practicum is simulated online and interactively so that students are interested in learning. The learning media developed can increase student interest because of good visualization and simple interactive movements in the media itself, for example clicking and sliding. The existence of audio that supports material explanations and practicum instructions or practicum steps also makes it easier for students to carry out work procedures so that nothing is missed or there is a work stoppage on the learning media.

Animation can be incorporated in many biology learning materials, emphasizes many experimental techniques, relevant sources, applications, and requires some aspects of hands-on activities for students that involve pointing and clicking (Alvarez, 2021). There are additional before and after buttons. The button aims to return to the previous step or see the next step. This button was made because the work procedure is quite complex in the practicum event of bacterial plasmid DNA isolation using many tools and materials, varying in shape and size. This is in accordance with the opinion of Wang & Huang (2015) that the size and type of font used in virtual laboratory learning media will determine the learning process, so the suitability of the design must be proportional (Wang & Huang, 2015).

The role of this virtual laboratory is very important in helping distance learning, limited learning tools and materials, limited time, and so on. Scientific learning and student skills can be improved through virtual laboratories, but must be in accordance with the CP and ATP of learning, so that objectives can be analyzed and completeness and interrelated procedures in accordance with the theory or material that must be mastered by students. Gene's lab can be accessed for free by students.

The language aspect in the media readability test is included in the material aspect. The value of the material aspect of the media readability test is very good at 89.78%. In general, this material aspect tests the suitability of the content of the material, the ease of language, the attractiveness of the images, and the flow of practicum in the media, as well as the suitability of evaluation questions with learning objectives. This is in accordance with the opinion of Amalia & Maknun (2022) that this benefit aspect is closely related to student motivation and interest in the learning process. Increased learning motivation is also able to increase students to gain knowledge and develop their cognitive abilities (Amalia & Maknun, 2022).

The acquisition of a very good readability value is because the virtual laboratory learning media Lab Gene has been revised based on suggestions from material expert validators and media experts. Kapilan et al., 2021, which states that by using a virtual laboratory, more than 90% of students feel happy and state that their learning process is improved by virtual laboratory experiments (Kapilan et al., 2021).

CONCLUSION

The validity of the STEM-based Gene Lab virtual laboratory was declared valid with a value of 90.10% or included in the very high category (very valid) by material experts and 83.75% or included in the very high category (very valid) by media experts. Meanwhile, the results of media readability (rumpang analysis) by 9 students at SMAN 1 Sumber obtained 89.03% with a very good category. This shows that the STEM-based Lab Gene virtual laboratory learning media is feasible to be implemented in schools to improve students' science literacy.

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