JSER

Journal of Science Education Research

Journal homepage: www.journal.uny.ac.id/jser

Development of Web-based Science Learning to Improve ICT Literacy and Conceptual Understanding Skills

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Keywords
Web-based science learning, ICT literacy, conceptual understanding

Abstract
The study aimed to 1) produce feasible web-based science learning media, 2) find out the effectiveness of the web-based science learning media for improving ICT literacy, 3) reveal the effectiveness of the web-based science learning media for improving conceptual understanding, and 4) determine the practicality of the web-based science learning media assisted by Google Sites on the Interaction of Living Things material. The study was a research and development (R&D) with the ADDIE model. Data collection instruments comprised of feasibility sheets, students' readability sheets, ICT literacy sheets, ICT literacy observation sheets, and pretest-posttest sheets of conceptual understanding. The research design was one group pretest-posttest in class 7H of SMP Negeri 2 Adiwerna with 16 students. The data analysis techniques used were paired sample T-test, effect size, and N-gain. The results of the study were that the web-based science learning media was 1) feasible to use in science learning, 2) effective in improving ICT literacy, 3) effective in improving conceptual understanding, and 4) practical for learning the interaction of living things material.

INTRODUCTION

The development of science, technology, and 4.0 industrial revolution influences various aspects of life, including education. The demand for graduates to be skilled, creative, and independent is a big concern. To fulfill this demand, the Ministry of Education and Culture has provided a policy that the learning process must be carried out using Information and Communication Technology (ICT) devices from home through distance or online learning. In the implementation process, distance education can freely use various learning resources and learning media (Ulfah, 2020).

Technology and media can play a prominent role in learning, which, if associated and specifically designed, can contribute to the effective learning of all students and help them reach their highest potential regardless of their innate abilities (Smaldino, Lowther, & Russell, 2011). To achieve this, teachers are required to use interactive learning media.

The internet is an example of interactive technology, which is developing very rapidly and has made the barrier between the virtual and real world disappear. There are many things in the real world that are easier to do in the virtual world, for example, e-learning in a network via the web. The concept of learning services through ICT is then known as web-based learning (Susanti, 2008).

During the pandemic, science learning at SMP Negeri 2 Adiwerna was conducted using a distance learning system that use ICT in the form of video conferences and WhatsApp groups. However, students only receive materials and concepts from the teacher during the learning process in the form of photos and documents given by teachers. The teacher becomes the only source of learning for students, which leads to the lack of students' participation.

Learning that does not involve students' skills in digital hands-on activities makes students less habitual in using their devices, such as smartphones and laptops, as media to get learning information at school. The lack of capability of teachers and students also affects the habit of using technology tools in schools, so this causes the lack of use of interactive media in the classroom during the implementation of the limited face-to-face learning system. The use of ICT devices at SMP

Negeri 2 Adiwerna, such as computers in the computer laboratory, is only carried out at certain times, for example, during the minimum competency assessment.

The interaction of living things is one of the science materials for grade 7 in the 2nd semester, which has various concepts of the relationship between one and other living things and their environment. The ability to understand concepts in the interaction of living things, like the previous materials, must be presented and delivered through an interactive process. With this approach, students can develop their concepts through habituation to the use of ICT-based media so that competence can be achieved through a student-centered approach.

Kustandi & Sutjipto (2013) stated that learning media is a tool to help the teaching and learning process and serves to clarify the meaning of the message conveyed so that it can achieve learning objectives better and more perfectly. The computer acts as an additional learning aid and can be used as a presenter of information on the content of the subject matter and exercises. Meanwhile, Rusman (2013) argued that, organizing web-based learning is not merely copying and pasting learning materials to be accessed via a computer. The web is not only used as an alternative media, instead of paper to store various documentation or information. Kaman (2021) stated that the web has advantages, such as Google Sites, which are the easiest and quickest way to access information. People can collaborate to attach files and information from other Google applications such as Google Docs, Sheets, and Forms.

One of the efforts to improve students' ICT literacy skills and understanding science concepts on the topic of Interaction of Living Things is by applying web-based learning. The developed product aims to emphasize students to actively construct science concepts from the problems given, as well as to explain the concepts, and apply these concepts digitally.

Based on the problems and backgrounds, the study develops web-based science learning assisted by Google Sites on the Interaction of Living Things topic to improve ICT literacy skills and conceptual understanding for 7th-grade students of SMP Negeri 2 Adiwerna. The objectives of the study are as follows: i) to determine the feasibility of web-based science learning assisted by Google Sites on the topic of Interaction of Living Things, ii) to determine the effectiveness of web-based science learning assisted by Google Sites on the topic of Interaction of Living Things to improve ICT literacy skills, and iii) to determine the effectiveness of web-based science learning assisted by Google Sites on the topic of Interaction of Living Things to improve the ability of conceptual understanding skills, and iv) to find out the practicality of web-based science learning assisted by Google Sites on the topic of Interaction of Living Things to improve ICT literacy skills and conceptual understanding for 7th grade students.

RESEARCH METHOD

The study used the Research and Development (R&D) method. The development model used the ADDIE model according to Dick and Carey (1996), which consisted of five stages: Analysis, Design, Development, Implementation, and Evaluation. The research design used a one-group pretest-posttest design. A measurement was carried out in one group of subjects (pretest) by performing treatment within a particular period, and then taking a second measurement (posttest) on the research variables.

The subjects were 16 students of 7th grade students at SMP Negeri 2 Adiwerna, Tegal Regency, Central Java. The study was conducted in February 2022. The data collection techniques used the purposive sampling method to select a sample determined by the researcher. The instruments were product validation assessment, students' response questionnaires, ICT literacy questionnaires, ICT literacy observation sheets, and pretest-posttest questions on conceptual understanding. The instruments were developed based on the review of supervisors, expert lecturers, and empirical tests.

The feasibility of the products was assessed by the validators using a Likert scale of 1 – 4. All data obtained in each feasibility assessment were then added up to be referred to as the actual score (X). Then, the actual quantitative score was converted into a qualitative score by referring to the conversion of the score on a scale of five to determine the feasibility of the quality of the developed web-based science learning. The reference for changing the score to a scale of five is presented in Table 1.

Table 1. Conversion of quantitative assessment scores to qualitative category (Widoyoko, 2011).

Score	Score Range	Category
A	Xi +1.80 SBi < X	Very High
B	Xi + 0.60 SBi < X Xi + 1.80 Sbi	High
C	Xi – 0.60 SBi < X Xi + 0.60 Sbi	Medium
D	Xi – 1.80 SBi < X Xi – 0.60 Sbi	Low
E	X < Xi -1.80 SBi	Very low

The normality test was carried out as a prerequisite test for the data distribution, which aimed to determine the normality of the data, whether the data is normally distributed or not. The normality test used the Shapiro-Wilk test because the data was less than 30 respondents. After normally distributed data were obtained, the paired sample t-test is then carried out to compare the differences between the two paired data samples using the normally distributed data.

Effect size analysis used Cohen's d formula, which is processed using the Effect Size Calculator. The effect size values were then interpreted using the criteria of Cohen and Morrison (2011) in Table 2.

Table 2. Cohen's d criteria.

Cohen's d score	Criteria
0 - 0.20	Very Weak
0.21 - 0.50	Weak
0.51 - 1.00	Medium
> 1.00	Strong

The analysis results of the increase in ICT literacy and conceptual understanding were seen from the normalized pretest-posttest scores to determine the gain score. The results of the gain score calculation were determined based on the criteria in Table 3.

Table 3. Criteria for increasing N-Gain.

N-Gain	Category
$g \geq 0.7$	Low
$0.3 > g > 0.7$	Average
$g \leq 0.3$	High

RESULTS AND DISCUSSION

The web-based science learning assisted by Google Sites was developed through the ADDIE model, which consists of Analysis, Design, Develop, Implementation, and Evaluation stages. The Analysis stage consists of initial analysis, student analysis, task analysis, concept analysis, and formulating the learning objectives. The results of the initial analysis show that learning science at SMP Negeri 1 Adiwerna requires a learning media that is interactive and engaging due to device limitations. This problem makes students lacking in participation and competence in ICT literacy and conceptual understanding. Hence, learning media are needed to attract students to participate directly in constructing the concept of the learning material but still can maximize the learning process according to the ICT literacy and conceptual understanding indicators.

The Design stage includes preparing a web-based science learning design, including research instruments, learning instruments, media selection, format selection, and the initial design of the web-based science learning. The research instruments are product validation assessments for expert lecturers and teachers, product questionnaires for students, validation sheets for the ICT literacy questionnaires, and pretest-posttest questions for conceptual understanding. Learning instruments ware made, such as lesson plans, worksheets, pretest-posttest questions for conceptual understanding, observation sheets, ICT literacy questionnaires, and media response questionnaires into the developed learning media, which are empirically tested. The web-based science learning media is chosen since it has easy access and helps the process of teaching and learning remotely during the research period in the Covid-19 pandemic. At the time, students study every two days at home independently using their devices. The tool used in developing the web-based science learning media is Google Sites as a place for the learning content.

The development stage includes the development of the revised media based on the validators' input through data collection instruments in the form of product validation assessments for expert lecturers and teachers, students' readability sheets, ICT literacy questionnaires, ICT literacy observation sheets, and pretest-posttest questions for conceptual understanding. These instruments are developed based on the review of supervisors, expert lecturers, and empirical tests. The results of the assessment of media and material aspects are presented in Tables 4 and 5.

Table 4. Conversion result of the media aspect from the validation score.

No	Aspect	V1	V2
1	Media Display	3.6	3
2	Software engineering	4	3.33
	Average	3.83	3.17
	Category	Very high	High

Table 5. Conversion result of the material aspect from the validation score.

No	Aspect	V1	V2
1	Content and Material	3.83	3
2	Language	4	3.67
	Average	3.75	3.13
	Category	Very high	Average

The empirical test results produce questions of conceptual understanding where the distribution of items is evenly distributed according to the level of difficulty in logit -2.0 to +3.0. Of the 20 questions made, there is one question in the very easy category, four in the easy category, ten in the medium category, two in the difficult category, and two in the very difficult category. Test item number 18 is considered the easiest question, and number 20 is the most difficult question.

Question number 20 is invalid, very difficult, and has no discrimination index. Therefore, the question is replaced with another question with a lower level of difficulty so that it can be tested. Questions 11 and 17 are valid, but the discrimination index is fair. This means that minor revisions are made according to the theory by Kurniawan (2021) that items with Pearson-Correlation values between 0.3 to 0.4 require minor revisions. In addition, the other 13 questions are already valid, so they can be considered feasible as pretest-posttest instruments. After the revision, the questions are ready to be presented to students of class VII. According to the theory of Rosana and Setyawarno (2016), the item with the value of sig. < 0.05 is valid.

The implementation phase includes the application of web-based science learning developed for 7th grade students of SMP Negeri 2 Adiwerna. The trial using the one-group pre- and posttest design shows an increase in ICT literacy and understanding of concepts in students. The test results are presented in Table 6.

Table 6. Results of the test.

Aspect	*Pretest* Average	*Posttest* Average	*N-gain*	*Effect Size*
ICT literacy	1.99	3.13	0.75	3,922
Conceptual Understanding	40.94	74.06	0.56	2,954

The results show that the N-gain of ICT literacy is 0.75 in the high category, while the conceptual understanding is 0.56 in the medium category. The effect size obtained for ICT literacy is 3,922 in the high category, and the conceptual understanding is 2,954 in the high category as well. Data on the ICT literacy assessment and conceptual understanding at the beginning and the end of learning are also analyzed. Based on the prerequisite test, it is found that the value of ICT literacy and understanding of students' concepts is normally distributed, so the hypothesis test is carried out using a paired sample t-test to compare the difference in scores. The results of the paired sample t-test analysis are presented in Table 7.

Table 7. Paired sample t-test.

Aspect	T	df	Sig. (2-Tailed)
ICT literacy	-10,356	15	.000
Conceptual understanding	-16,704	15	.000

Based on the analysis, it is obtained that Sig. (2-tailed) 0.000 < (0.05), then H0 is rejected. So, there is a difference between the initial and final scores of ICT literacy and students' conceptual understanding using web-based science learning. The t-value is -10.356 and -16.704, which indicates a negative number because the average ICT literacy and conceptual understanding at the beginning of learning are lower than the average value in the final questionnaire. It is interpreted that using web-based science learning assisted by Google Sites can significantly improve students' ICT literacy and conceptual understanding. The results of the increasing value of ICT literacy and conceptual understanding are presented in Figures 1 and 2.

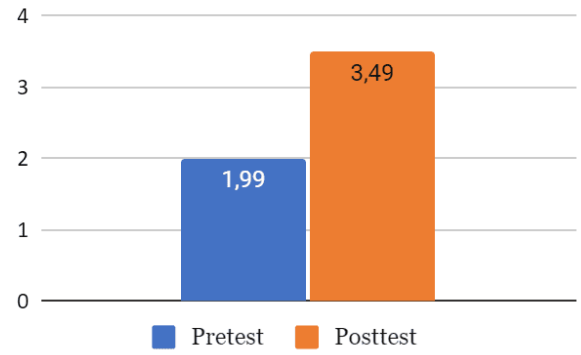

Figure 1. The Increase of the ICT literacy.

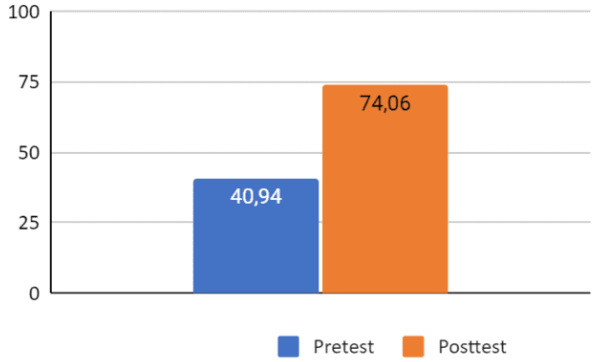

Figure 2. The increase of the conceptual understanding.

Students' responses show that web-based science learning is in the very practical category, which is presented in Table 8. The overall rating of all aspects, i.e.: software engineering, visual communication, and learning design, is 3.63 with a very high category.

Table 8. Students' responses to web-based science learning.

Aspect	Total Average Score	Category
Software Engineering	3.52	Very high
Visual Communication	3.69	Very high
Learning Design	3.78	Very high
Overall Rating	3.63	Very high

The evaluation stage consists of the phase II revision, which is carried out for the improvement and refinement of the web-based science learning assisted by Google Sites draft II. The evaluation is based on the results of students' responses in the form of media response questionnaires carried out through product trials and observations at SMP Negeri 2 Adiwerna.

The web-based science learning developed using Google Sites provides opportunities for students to be more involved in hands-on learning activities in constructing their concepts. In relation to a study conducted by Irawan, Maria, and Mursyid (2018), the use of web-based learning media can be used for remediation activities. This is evident from changes in students' conceptions before and after using the learning media.

Web-based science learning has a feature, called test your skill ("*Uji Kemampuanmu!*"), which can be used in core learning activities where students can learn with Student Worksheet (LKPD) directly and digitally on the website. Teachers can also share materials, videos, images, and links that students can easily download and access. Using web-based science learning with the help of Google Sites makes it easier for students to do assignments, carry out more interactive discussions, and work on the LKPD. The increase in ICT literacy after being given web-based learning follows the results of a study by Mustika (2013) that, ICT-based science learning can significantly improve students' ICT literacy compared to non-ICT-based learning. The developed web-based science learning, including ICT-based activities, makes students can work on the digital LKPD of the web-based science learning.

According to Purba (2019), the increase of conceptual understanding after being given web-based science learning means that the web-based interactive learning applications can be used as learning media to increase understanding of concepts more effectively and efficiently. Moreover, it already includes materials that are described with attractive visualizations and can describe abstract concepts more clearly through illustrations and explanations.

CONCLUSION

Based on the data analysis and discussions, it can concluded that the web-based science learning assisted by Google Sites on the topic of Interaction of Living Things is 1) feasible to be implemented in science learning according to material and media aspects, 2) effective in increasing students' ICT literacy based on the effectiveness test, 3) effective in increasing students' conceptual understanding based on the effectiveness test, and 4) practical to be implemented in learning based on students' responses.

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