The development of E-learning media to improve students’ science literacy skill in Senior High School

Miranti Risniawati¹*, Vina Serevina², Mutia Delina²
¹Magister of Physics Education Student, Faculty of Mathematics and Science, Universitas Negeri Jakarta, Indonesia
²The Lecturer of Physics Department, Faculty of Mathematics and Science, Universitas Negeri Jakarta, Indonesia

*mhi2ranti@gmail.com

Abstract. The changes in curriculum and information technology bring the integration of technology and education as well. In education today, a learning process is not restricting to traditional one way face-to-face classroom interaction, but also to an online learning environment. The online learning environment requires proper e-learning media that can be accessed anywhere and anytime. This research developed e-learning media to improve the high school student’s science literacy. This research conducted Research and Development methods with ADDIE approach which consist of five steps; analyse, design, develop, implement and evaluation. The e-learning media was validated by several experts. Results of validation test showed score 85.13% for media validation, 80% for material validation, and 81.04% for learning validation. The result of this research, 25 items of this instrument were valid from 50 items by using product moment validation test and the reliability test result 1.02 by using Alpha Cronbach. The media also passed the product usability evaluation by students and teachers. The results show that the develop of e-learning media can improve students’ science literacy skill with N-Gain test score 0.57. Based on table of criteria N-Gain, e-learning media can improve students’ science literacy skill in the medium category.

1. Introduction

The world gets to start the global era where Information Communication and Technologies (ICT) are the important aspects of our lives including education [19]. Computers are the first thing that will be thought of when hearing the word ICT. Educational institutions will naturally use computers in carrying out their activities. It is very clear that the use of computers in education is an undeniable need for both individual and group needs [29]. But, based on the questionnaire result, 88% of teacher respondents still use the blackboard in learning.

The role of computers can be replaced by laptops and smartphones. Computers, laptops, and smartphone cannot be separated from the existence of internet. The latest results of the International Telecommunication Union (ITU), a UN organization that manages telecommunications and information technology, shows that three billion of world population have access to the internet [7]. While from the statistical data of the Indonesian Internet Service Providers Association (APJII), the users of internet in Indonesia in 2017 amounted to 54.68% or a total of 143.26 million Indonesian people. From ownership of gadgets and the availability of online networks in schools’ it turns out that only 2% of the total respondents who use gadgets to find material by reading e-books.
Together with the global role of ICT, learning is not only appears in schools but also in every phase of life and environment. Therefore, we need a learning media that can be used by teachers and students at any time using computers, laptops, and smartphones. In long-life learning, ICT especially learning media has a big influence [10]. Based on the questionnaire result, 56% of teachers seldom use online learning media such as e-learning. But 96,1% of students need website learning media or e-learning that can be accessed wherever and whenever. Online learning (e-learning) invites students to access subject matter wherever and whenever they can as long as internet access is available [1]. Online learning (e-learning) is also progressively developing in distance learning [25].

In the digital age era marked by the development of ICT, there are various abilities that must be mastered by students to be able to compete with a capable generation from other countries. One of these abilities is literacy ability. Science literacy is one of the main forms of literacy in the digital age, with the ability to adapt in every change, think creatively, make decisions, and solve problems [8]. Whereas according to Chandra, science literacy is the main goal of education in the world [4].

Based on the presented background of problems, the researcher focuses on the development of e-learning media to improve student's science literacy in high school Newton's Laws, Gravity's Law, Work and Energy, Momentum and Impulse, and Simple Harmonic Motion Material at 3 Senior High School Depok at 10th grade.

2. Literature Review

2.1 ADDIE Development Model

According to Tung, ADDIE stands for Analyze, Design, Develop, Implement, and Evaluate [28]. The stages of activities contained in the ADDIE model consist: 1) Analyze: needs analysis, literature study, and observation; 2) Design: web design, and identification of basic competencies; 3) Develop: teaching materials adapted so that they can be used; 4) Implement: the media is implemented according to the design that has been developed; 5) Evaluate: the process for determining the value, price, and benefits of an object [17]. The research design that will be carried out is as follows.

![ADDIE's model](image)

Figure 1 ADDIE’s model [27]

2.2 Learning Media

Sudjana suggested learning media as teaching aids and delivering material to facilitate the process of interaction between teachers, students, and their learning environment [26]. Learning media is defined as an intermediary and a tool to convey messages in the form of learning material from the sender of the message (teacher) or material to the recipient of the message (students) so that there are a learning and teaching interaction [23]. Learning media can be interpreted as teaching aids in the form of communication that can be seen and heard (audio-visual communication) as an ingredient for delivering material from the teacher to students [3]. While Djamarah and Zain state that learning media is a source of learning, media is broadly defined as human beings or events that allow students to gain knowledge [6].

2.3 E-learning

E-learning is a form of distance education conducted by internet media [31]. Naidu also stated that e-learning is a series of activities that are consistent with utilizing information and communication technology in which there are learning activities individually and in groups that can be connected or
not with a network, computer or other devices [11]. E-Learning is a learning system with electronic media as a tool for learning activities [5]. According to the American Society for Training and Development (ASTD), e-learning is a set of applications and processes including web-based learning, computer-based learning, and virtual digital classes [20]. Gilbert, Jones, and Michael suggested that e-learning is a learning activity with electronic tools for learning [30].

2.4 Characteristics e-learning
According to Rusman, e-learning has characteristics of interactivity, independence, accessibility, and enrichment. Interactivity means that e-learning provides more communication channels, both synchronous, such as chat or messenger, asynchronous as discussion forums. Independence signifies that e-learning is flexible in terms of providing time, place, type of teaching, and teaching language. This is what causes e-learning to make students as centers of learning (student-centered learning).

Accessibility implies that with the existence of e-learning, learning resources will be more accessible and the access range is wider when compared to learning resources in conventional learning. Enrichment which includes learning activities, presentation of lecture material, and training materials can be done in e-learning through video streaming, simulation, and animation [20].

2.5 Advantages and disadvantages e-learning
Advantages:
1. Teaching materials in e-learning are independent and can be stored on a computer
2. Facilitate learning activities and can be done with simple interactions
3. There is no time limitation in accessing material

Disadvantages:
1. Lack of direct interaction between teacher and students or even between students themselves
2. The teacher must master the learning techniques with ICT
3. The role of the teacher experiences a shift
4. Formation of values and attitudes of students was slow

2.6 Science literacy skill
The definition of PISA science literacy in 2015 is the ability to deal with issues related to science, and with scientific ideas, as reflective citizens. A person who has scientific literacy requires competence to explain phenomena in daily life scientifically, evaluate the phenomena and design scientific investigations, and interpreting scientific data and evidence [15]. While the understanding of PISA scientific literacy according to Rustaman is the capacity to identify questions and draw conclusions based on existing data and then take decisions on the interaction of nature and its surroundings by using scientific knowledge and abilities [21]. Whereas according to Geban (2015) science literacy is defined as an understanding of scientific concepts and techniques used to make decisions as members of modern society.

PISA 2015 [15] divides aspects of scientific literacy into four aspects consisting of aspects of context, content (knowledge), competence (process) and attitude [16].

2.6.1. Context aspect. In PISA 2015, the context aspect focuses on issues at the private, local/ national, and global levels involving science and technology. The scientific context used is health, natural resources, environmental quality, hazards, and limitations on technology and science.

2.6.2. Content aspect (knowledge). The content aspect explains about the epistemic and procedural knowledge. Procedural knowledge is related to practices and concepts that form the basis of empirical investigations such as repeating measurements to minimize errors and reduce uncertainty, control variables, and standard procedures for representing and communicating data. Epistemic knowledge includes an understanding of the functions of questioning, observations, theories, hypotheses, models,
and arguments to play in science; recognition of various forms of scientific inquiry; and the role in building trustworthy knowledge.

2.6.3. Competency aspect (process). The first competency is the ability to provide a clear explanation of daily life phenomena and their impact for society. The second competency is knowledge of scientific inquiry to identify questions that can be reasoned by scientific questions, identify whether proper procedures are used, and propose several ways for such questions to be answered. The third competency is the competence to interpret data, evaluate data and evidence scientifically and evaluate whether the conclusion is justified.

2.6.4. Attitude aspect. Aspects include how to respond to science issues. This aspect includes feeling interested in science, assessing a scientific approach, as well as awareness and concern for environmental issues [14].

3. Research Methods

The purpose of the study was to find out that e-learning media that were developed were feasible to be used as learning media and to find out whether the development of e-learning media could improve the scientific literacy of class X high school students. This development research uses the ADDIE model. The ADDIE model consists of five stages, namely analyze, design, develop, implement, and evaluate. But this research only arrived at the implement stage. The first phase of ADDIE is the analysis (analysis) is a preliminary study covering needs analysis, literature study, and observation. The second phase, design, started from the selecting of moodle 3.5 LMS based on the needs analysis results for this research. After selecting the LMS moodle, the e-learning design flowchart is made, web template design, material typing, and media collection. The third step, began with the creation of the site home. Topics or material that will be used based on the results of the needs analysis is Physics material for 10th grade namely Newton's Motion Law, Newton's Gravity Law, Business and Energy, Momentum and Impulses, and Harmonious Vibration. Activities that exist in e-learning are concept maps, learning materials (text, images, animations, videos), sample questions, quizzes, problem training, chat, discussion forums, simulations equipped with usage instructions, practical worksheets, material files and summaries, references, and equipped with instructions for use.

E-learning that has been developed will be validated by media, material, and learning experts. Validation instruments using the Likert scale 1-5 [27]. After the validation test is carried out, the scores obtained are interpreted as follows:

| Table 1 Score Interpretation |
|-------------------------------|
| **Percentage** | **Criteria** |
| 0% - 20% | Not Feasible |
| 21% - 40% | Less Feasible |
| 41% - 60% | Enough Feasible |
| 61% - 80% | Feasible |
| 81% - 100% | Very Feasible |

In addition to the validation test carried out by experts, a feasibility test was conducted by the teacher, a small-scale test, and a large-scale test. Interpretation of scores obtained in accordance with the table above.

The scientific literacy instruments used were 25 questions with essay question types and Likert scale. The instrument will be through the validity test, reliability test, distinguishing power, and level of difficulty. To find out the increase in the scientific literacy of students, the students were given a pretest and posttest. The data obtained will be carried out test requirements for data analysis, namely the normality test and homogeneity test. Next to prove the effectiveness of e-learning media can use the N-Gain analysis technique as follows [9]:
4. Results and Discussion

4.1 Results

There are three users in this e-learning system. The users are admin, teachers, and students. The following is an explanation of the facilities for each user.

(a) Admin. Admin can set the display, add topics, add the courses/activities, edit, and delete users, and set access rights (privileges). Admin can also manage questions and values weight done by students.

(b) Teachers. The teacher can upload learning material, make quiz and assignment, set the date, make and participate in the discussion forums, manage questions and values weights, give and see the students’ scores.

(c) Students. Students can see the material, do and download the assignment, do the quiz, see their score individually, and participate in chatting and discussion forum.

There are so many activities in this e-learning. Here the activities in this e-learning, started from site home.

![Site home]

Figure 2. Site home
Figure 3. Activities in the course

Figure 4. Discussion Forum
E-learning that has been developed will be tested by media experts, material experts, and learning experts. The results of validation by media experts can be seen in the Figure 5.

![Figure 5. E-Learning Media Expert’s Validation Result](image)

From the result of e-learning media validation instrument obtained the average value is 85.13%. Based on the criteria for feasibility, it can be categorized as the criteria “very feasible”. The results of validation by material experts can be seen in the Figure 6.

![Figure 6. Material Expert’s Validation Result](image)

From the result of material validation instrument obtained the average value is 80%. Based on the criteria for feasibility, it can be categorized as the criteria “feasible”. The results of validation by learning experts can be seen in the Figure 7.
From the result of learning validation instrument obtained the average value is 81.04%. Based on the criteria for feasibility, it can be categorized as the criteria "very feasible". After testing the validation of the validator, the next stage of the research is the feasibility test for teachers and students (small scale test). Based on the results of the teacher trial, the average percentage was 95.9%. Based on the criteria for feasibility it can be categorized as "very feasible". Meanwhile, the results of small-scale tests by students were 79%. Based on the criteria feasibility, it can be categorized as "feasible". After considering the results of the teacher's feasibility test and the small-scale test of students, a large-scale test was conducted. Large scale testing involves all research samples totaling 104 people. The large-scale test results were 83%. Based on the criteria for feasibility, it can be categorized as "very feasible".

To find out whether e-learning can improve students' scientific literacy skills, the technique is to provide pretest and posttest instruments to students. Before being used, instruments for scientific literacy were tested for validity and reliability testing. The trial of this question instrument consisted of 50 questions and tested on the XI grade students of 30 Senior High School Jakarta. Based on the results of the validity test, 25 valid questions were obtained and the reliability test result 1.02 by using Alpha Cronbach.

Large-scale trials were carried out at the 3 Senior High School Depok by using three classes, with a sample of 104 students. Large-scale trials were conducted by giving the instruments of science literacy questions pretest and posttest which were 25 questions.

Based on the calculation results obtained the average pretest value for all samples is 38.54 with the highest value is 56 and the lowest value is 18. While the average posttest value for all samples is 73.95 with the highest value being 92 and the lowest value is 48. To know about the increasing of student’s science literacy skill, it can be calculated by N-Gain test. The result of N-Gain test for student’s science literacy skill can be seen in table 3.

| Class                | n   | Average pretest | Average posttest | N-Gain | Category |
|----------------------|-----|-----------------|------------------|--------|----------|
| Science Literacy     | 104 | 38.53           | 73.98            | 0.57   | Medium   |

From the data and the results of the N-gain calculation, the N-gain score is 0.57. Based on the N-gain criteria table, the score falls into the "medium" category. Thus, it can be concluded that e-learning media can improve students' scientific literacy skills in the medium category.
4.2 Discussion
Based on the calculation of the N-gain value of each student, it was found that there was an increase in the low, medium, and even high categories. This happens because of several things, including the initial abilities of different students, lack of understanding of students about the use of information technology, or possibly many other internal factors. In addition, the increase in scientific literacy skills is categorized as being due to the lack of research time so that the treatment is not optimal, the lack of time for students to read the material, and the lack of invitation to students to understand and interpret e-learning material.

However, despite the moderate N-gain value, students are very enthusiastic in accessing and studying e-learning. In addition, there are chat and discussion forums activities where students can directly communicate and discuss e-learning without having to open another application. Or in other words e-learning can help distance learning. In addition, e-learning can be accessed and studied by the teacher. So that e-learning is not only learned by students but also can be learned by the teacher in terms of material and its use. This means that with e-learning lifelong learning can be carried out without being restricted by age.

Rapid technological developments, especially the internet, enable us to develop e-learning that supports lifelong learning and distance learning. E-learning can also create active learning. Besides being able to increase to e-learning can also increase the motivation of students. This is continuous with the results of several other studies.

Al Rsa’i stated that teaching using website technology can improve scientific literacy. Besides science teaching with a website can also increase motivation and positive trends for students to gain scientific knowledge. The relationship between website technology and student motivation has a central role in developing scientific literacy and continuous learning [2]. The main reason for students choosing the online Physics learning course is because it is flexible, interested, and curious. In addition, the presentation of videos related to life is very interesting because it is relevant to everyday life. Online learning or e-learning also allows active learning with student interaction in accessing material, working on quizzes, and participating in discussion forums and chatting. Students are also more motivated to learn if the quiz they are working on directly gets value and feedback from the teacher. This can be realized by using online learning or e-learning [12]. The attitude and trust of students towards positive online learning.

Online-based multimedia modules have a positive impact on mastering the concepts of students and improving the performance of students in the classroom. Teachers also need to develop online learning for distance learning in the future [22]. Online learning with android can improve students’ scientific literacy in aspects of science knowledge. Generally, the use of online technology can also make learning more active, creative, fun, and provide wider knowledge of science [13]. The use of web and e-learning media with learning materials equipped with videos, quizzes, problem training, and assignments can improve student learning outcomes and the culture of independent learning [24]. Learning using e-learning is very effective because each student can choose their level of learning [18].

5. Conclusion
E-learning media expert validation result showed 85.13% (very feasible). Material expert validation result showed 80% (feasible). Learning expert validation result showed 81.04% (very feasible). Feasibility test result from teachers showed 95.9% (very feasible) and large scale test from students showed 83%. This E-learning can improve students’ sciece literacy skill, proved by N-gain result 0.57 (medium category). So, development of E-learning on can improve students’ science literacy skill.

Acknowledgements
We gratefully thank to all experts for comments greatly improved the manuscript.
References

[1] Aase, S. 2000. Online Learning Goes The Distance. International Data Corp., http://www.itdl.org/journal/Jan_04/article02.htm.

[2] Al-Rsa’i, M. S. 2013. Promoting Scientific Literacy by Using ICT in Science Teaching. International Education Studies; Vol. 6, No. 9; 2013 ISSN 1913-9020 E-ISSN 1913-9039, 175-186.

[3] Arsyad, A. 2014. Media Pembelajaran. Jakarta: PT. Raja Grafindo Persada.

[4] Chandra, V., & Watters, J. J. 2012. Re-thinking Physics Teaching With Web-based Learning. Computers & Education 58, 631-640.

[5] Daryanto. 2013. Media Pembelajaran Peranannya sangat Penting dalam Mencapai Tujuan Pembelajaran. Yogyakarta: Gava Media.

[6] Djamalah, S. B., & Zain, A. 2014. Strategi Belajar Mengajar. Jakarta: PT Rineka Cipta.

[7] ITU and United Nations. 2014. The World in 2014: ICT Facts and Figures. Geneva: International Telecommunication Union. www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2014-e.pdf.

[8] Klausner, R. D. 2012. National Science Education Standard. Washington DC: National Academy Press.

[9] Lestari, K. E., & Yudhanegara, M. R. 2017. Penelitian Pendidikan Matematika. Jakarta: Refika Aditama.

[10] Marjan, M. 2014. The Impact of Web-Based Learning with a Problem-Solving Approach on Logical Thinking Development Mathematics Education Trends and Research. doi:10.5899/2014/metr-00055, 1-10.

[11] Naidu, S. 2006. E-Learning A Guidebook of Principles, Procedures, and Practices 2nd Edition. New Delhi: Commonwealth Educational Media Center for Asia.

[12] Ng, W., & Angstmann, E. 2017. Promoting Physics Literacy Through Enquiry-Based Learning Online. Journal of Education in Science, Environment and Health (JESEH), 3(2). DOI:10.21891/jeseh.326750, 183-195.

[13] Nurwahidah et al. 2017. The Effects of Project Based Learning Model with Android on Scientific Literacy and Digital Equippedness/ICT Literacy. International Journal of Sciences: Basic and Applied Research (IJSBAR) Volume 36, No 7, pp 190-205 ISSN 2307-4531

[14] OECD. 2016. How Does PISA for Development Measure Scientific Literacy?

[15] OECD. 2017. PISA 2015 Assessment and Analytical Framework: Science, Reading, Mathematical, Financial Literacy and Collaborative Problem Solving Revised Edition. Paris: OECD Publishing.

[16] OECD. 2017. PISA for Development Assessment and Analytical Framework: Reading, Mathematics and Science, Preliminary Version. Paris: OECD Publishing.

[17] Pribadi, B. 2014. Desain dan Pengembangan Program Pelatihan Berbasis Kompetensi. Jakarta: Prenada Media Group.

[18] Renata, Bednarova and Merickova Juna. 2012. E-learning as a Motivation in Teaching Physics. Science Direct Social and Behavioral Science 64 (2012) 328 – 331. International Educational Technology Conference

[19] Redecker, C., & Punie, Y. 2013. The Future of Learning 2025: Developing a Vision for Change. Future Learning, Vol. 1, 3-17.

[20] Rusman. 2012. Model-Model Pembelajaran. Depok: : PT Rajagrafindo Persada

[21] Rustaman, N. 2006. Literasi Sains Anak Indonesia 2000. Jurnal Puspensidik Vol I (3), 31-34.

[22] Sadagiani, H. R. 2011. Using Multimedia Learning Modules in a Hybrid-Online Course in Electricity and Magnetism. PHYSICAL REVIEW SPECIAL TOPICS - PHYSICS EDUCATION RESEARCH 7, 010102 (2011).

[23] Sani, B., & Kurniasih, I. 2017. Lebih Memahami Konsep dan Proses Pembelajaran Implementasi dan Praktek dalam Kelas. Jakarta: Kata Pena.

[24] Saraswati, I. 2016. Panduan Praktikum Kimia. Jakarta: Penerbitan CV Budi Utama.
[25] Singh, H., & Reed, C. 2001. *A White Paper: Achieving Success With Blended Learning.* Lexington, MA: Centra Software.

[26] Sudjana, N., & Rivai, A. 2013. *Media Pengajaran.* Bandung: Sinar Baru Algensindo Offset.

[27] Sugiyono. 2013. *Metode Penelitian Kuantitatif Kualitatif dan R & D.* Bandung: Alfabeta.

[28] Tung, K. Y. 2016. *Desain Instruksional Perbandingan Model dan Implementasinya.* Yogyakarta: Andi Offset.

[29] Usta, E. 2011. The Effect of Web-Based Learning Environments on Attitudes of Students Regarding Computer and Internet. *Procedia - Social and Behavioral Sciences* 28, 262-269.

[30] Wahyuningsih, M. 2017. *E-Learning Teori dan Aplikasi.* Bandung: Informatika.

[31] Wati, E. R. 2016. *Ragam Media Pembelajaran.* Jakarta: Penerbit ata Pena.