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Development of Science Literacy-Based Physics e-Module in Kinematics Motion

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Abstract: The purpose of this study is to describe the feasibility of the e-Module Based on Science Literacy (e-MLIST) in the Basic Physics course on the topic motion kinematics. The e-MLIST media could be the answer to the paradigm shift in the world of education during COVID-19. This study applied research and development with the Decide, Design, Develop, and Evaluate (DDDE) model to create the electronic modules. The e-MLIST has several advantages, such as the Module being electronic-based, which offers flexible utility. It means e-MILST can be used whenever and wherever it is located. The e-MILST could be used to train students' scientific literacy skills in Basic Physics One lecture on motion kinematics. In this case, e- MILST will be used as a source of learning and teaching materials in the Basic Physics One course, whether offline, online or hybrid. The analysis results show that the e-MLIST is very valid, with 91.69% validity, The practicality of using e-MLIST in basic physics lectures 1 motion kinematics material is 87.13% with excellent criteria and The effectiveness of the use of e-MLIST in basic physics lectures 1 motion kinematics material is seen from the improvement of students' science literacy skills by n-gain 0.57 with moderate criteria. This means that e-MILST is worthy of being used as a learning media in basic physics lectures 1 topic of motion kinematics.

Keywords: e-module, science literacy, physics learning.

Abstrak: *Tujuan dari penelitian ini adalah untuk mendeskripsikan kelayakan modul elektronik berbasis literasi sainse-MLIST pada mata kuliah Fisika Dasar pada topik kinematika gerak. Media e-MLIST bisa menjadi jawaban atas pergeseran paradigma dunia pendidikan selama COVID-19. Penelitian ini menerapkan penelitian dan pengembangan dengan model Decide, Design, Develop, and Evaluate (DDDE) untuk membuat modul elektronik. e-MLIST memiliki beberapa keunggulan, seperti Modul berbasis elektronik, yang menawarkan utilitas yang fleksibel. Artinya e-MILST dapat digunakan kapanpun dan dimanapun berada. e-MILST dapat digunakan untuk melatih kemampuan literasi sains mahasiswa pada perkuliahan Basic Physics One pada kinematika gerak. Dalam hal ini, e-MILST akan digunakan sebagai sumber belajar dan bahan ajar pada mata kuliah Fisika Dasar Satu, baik offline, online maupun hybrid. Hasil analisis menunjukkan bahwa e-MLIST sangat valid, dengan validitas 91,69%, Kepraktisan penggunaan e-MLIST pada materi kuliah fisika dasar 1 gerak kinematika sebesar 87,13% dengan kriteria sangat baik dan Efektifitas penggunaan e-MLIST dalam materi kinematika gerak fisika dasar 1 dilihat dari peningkatan kemampuan literasi sains siswa sebesar n-gain 0,57 dengan kriteria sedang. Artinya e-MILST layak digunakan sebagai media pembelajaran pada perkuliahan fisika dasar 1 topik kinematika gerak.*

Kata kunci: *modul elektronik, literasi sains, pembelajaran fisika.*

▪ INTRODUCTION

The COVID-19 pandemic that hit the world, especially the State of Indonesia, has changed the paradigm of life, especially in the education world. The learning paradigm has changed from what was initially direct learning to online learning and also hybrid learning. Because of such a change in the learning paradigm, it takes a media that can

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support it, as has been done in research on developing scientific literacy-based e-Modules, which will later be called e-MLIST. The e-MLIST is different from the modules developed by previous researchers because e-MLIST has features that can train students' scientific literacy skills in offline, online, or hybrid lectures.

Any type of learning platform: online, offline or hybrid, needs media that can facilitate students and lecturers so that the learning that is carried out can run well and be compelling, exciting and varied. In line with the previous research, it was found that (Sudarisman, 2015), that learning physics has a significant contribution to supporting the development of Science and technology; this is because physical Science is a fundamental science that underlies the development of Science and technology. Research results (ICASE, 2008) stated that students need adequate scientific literacy skills to live productively and obtain the best quality of life, as the goal of science education proclaimed by the Ministry of Education and culture. Likewise, the results of research (Liasari & Fitriana, 2014) state that the physical sciences have a significant role in all aspects of life; therefore, it is necessary to learn and teach students so that all Indonesian people can achieve an adequate science literacy community, but it also retains the nation's character to keep up with the times. In fact, from the results of the PISA test in 2018, it was found that the scientific literacy of Indonesian students was ranked 72 out of 78 countries, with a scientific literacy ability score of 396 (OECD, 2019). It indicates that the scientific literacy ability of Indonesian students is still low, so efforts are needed to improve it. The essence of scientific literacy, PISA defines that scientific literacy ability consists of the capacity to use scientific knowledge, identify questions, and draw conclusions based on existing facts and data to understand the universe and make decisions from changes that occur due to human activity (OECD, 2017). One indicator that can be used as an indicator is that individuals with high scientific literacy skills are those who can master concepts and can understand their application in everyday life and the world of technology (Yager, 2000).

The teaching and learning process cannot be separated from the communication process between teachers (lecturers) and students (students) in conveying a message or material conveyed by the teacher or a learning resource into a visual or verbal communication symbol. Communication between teachers and students in delivering material should be arranged as attractively as possible so that students can be motivated and learning Science and physics can be meaningful for students. Based on (Fitriani et al., 2014), meaningfulness in learning Science and physics can be obtained if students' scientific literacy skills are good. Meaningful learning can be carried out well if students can connect the newly acquired knowledge with previous knowledge (Haristy et al., 2013). It is in line with the learning theory presented by Piaget, which states that knowledge is the result of human thought processes that are constructed from the process of experience that is experienced continuously. Every time, a reconstruction can occur because of the new understanding gained through learning adaptation.

In carrying out lectures using the curriculum of Merdeka, lecturers should consider 21st-century competencies by utilizing advances in Science and Technology where students and lecturers are free to choose the learning resources and teaching materials needed. So, it is wise to provide a media that supports Science and technology-based learning, one of which is the creation of e-Modules that can train students' scientific literacy. The use of e-Modules in the lecture process is one

alternative in that lecturers can integrate advanced technology into the learning process so that learning becomes more exciting and varied (Jennifer et al., 2015). The- Modul is an application program that a teacher should develop in the 21st Century to provide a fun learning process by prioritizing students' understanding of concepts. E-Modules have been understood only in the form of text that can be opened with a PC or cell phone, but the e-Modules developed are designed in the form of text, video or animation that can be used to show real situations that are more convincing for students so that they can practice literacy science skills.

▪ METHOD

This e-MLIST development research is a type of Research and Development (R&D) that includes a series of step-by-step processes for the realization of a process, such as selecting appropriate media, designing media, piloting media, and evaluation (Jaknov, 2008). There are many development research models that can be used, one of which is used in this study is the DDD-E Model (Decide, Design, Develop, and Evaluate (DDD-E) as shown in Figure 1.

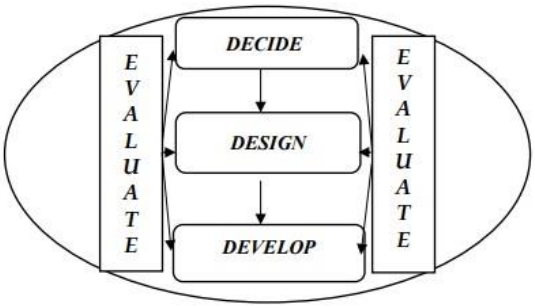


Figure 1. Research Design DDD-E

This research was conducted at the Department of Physics, FMIPA, Surabaya State University with the subject of the study being students of the Department of Physics Academic year 2022/2023. The sampling technique used in this study is simple random sampling, namely taking sample members of the population were randomly performed without regard to strata in a population (Sugiyono, 2019). e-MLIST media trial design using one group pretest and posttest design design. The sample in this study is the PFC 2022 class majoring in physics, FMIPA, Universitas Negeri Surabaya with a total of 27 students. Data collection techniques using media validity instruments, pretest-posttest instruments and student response questionnaire instruments.

The analysis in this study applied quantitative descriptive techniques with e-MLIST content validity instruments in terms of suitability of media with a lesson plan of Basic Physics One, content material, and layout and design. In addition, the further quantitative descriptive analysis used a Likert scale among others very valid score 4, valid score 3, not valid score 2 and very not valid score 1. The e-MLIST validity percentage score criteria are interpreted into criteria using intervals, including: (1) 81%-100% very valid, (2) 61%-80% valid, (3) 41%-60% adequate valid, (4) 21%-40% not valid and (5) 0%-20% very not valid. The developed e-MLIST is said to be suitable for use in lectures if the percentage of e-MLIST Validity is (>) 61%. The criteria for the

percentage score for the Validity of the e-MLIST instrument are as in Table 2; then, the developed e-MLIST is said to be suitable for use in lectures if the percentage of e-MLIST Validity is (>) 61%. (Ridwan, 2015).

Analysis of the practicality and effectiveness of using e-MLIST in lectures also uses quantitative descriptive analysis. The practicality analysis can be seen using the likert scale and described its practicality with intervals of (1) 81%-100% very practical, (2) 61%-80% practical, (3) 41%-60% quite practical, (4) 21%-40% not practical and (5) 0%-20% very impractical. (Ridwan, 2015), and also uses n-gain analysis to describe the improvement of students' science literacy skills. The developed e-MLIST media can be said to be feasible if it is valid, practical and effective

▪ RESULT AND DISSCUSSION

Development of e-Modul Based on Science Literacy

The product produced in this study is a science literacy-based e-module in the basic physics course on the topic of motion kinematics named e-MLIST. This media can be used as teaching material for lecturers and also as a source of student learning that can train students' science literacy skills. This e-MLIST product was developed using the DDD-E research design which can be described as follows:

Decide

At this stage, an analysis of the curriculum, lecture plans and materials in basic physics courses and the needs in lectures are carried out, which currently require alternative media that can be used in lectures offline and online and can train 21st century skills, one of which is science literacy. Based on this analysis, a decision can be made to develop a e-module based on science literacy.

Design

At this design stage, a schematic and macrostructure of science literacy-based e-modules is made based on the results of curriculum analysis, lecture plans and the need for alternative media in offline and online lectures. then design the e-MLIST cover and background using the adobe photoshop CS8 program, this aims to make the resulting e-MLIST media attractive and can motivate students to learn so that student science literacy increases. At this stage, a logo design is also carried out for e-MLIST media which is a branded media that will be registered for copyright at the Director General of Copyright of the Ministry of Law and Human Rights of the Republic of Indonesia.

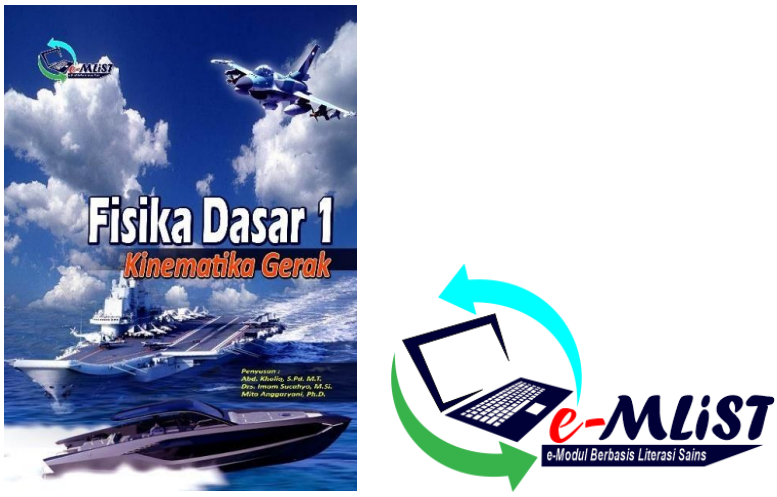
Develop

At this stage, the merger of several materials that have been designed is also carried out, ranging from e-module cover design, e-module background design, e-module content, contextual example videos, animation videos, images so that it becomes an interactive media that is given the name e-MLIST (science literacy-based e-module) in the basic physics course on the topic of motion kinematics.

e-MLIST developed by the researchers

Research on the development of Science Literacy-Based e-Modules (e-MLIST) in Basic Physics One, motion kinematics applied Decide, Design, Develop, and Evaluate

(DDD-E) presented in Figure 1. The analysis in this study applied quantitative descriptive techniques with e-MLIST content validity instruments in terms of suitability of media with a lesson plan of Basic Physics.



(a) (b)

Figure 2. (a) cover e-mlist (b) logo e-mlist

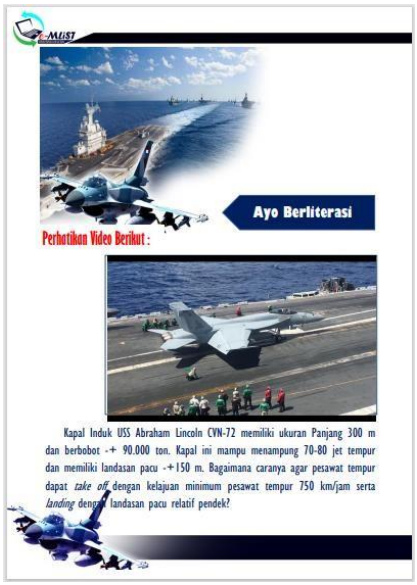


Figure 3. Content of e-mlist (train literacy of science - analyzing the fact)

Concepts of Kinematics in e-MLIST

The kinematics of motion can be described well if we can define quantities related to the kinematics of motion, for example, the magnitudes of distance, displacement, velocity, and speed. An object can be said to be moving if it moves from position 1 to position 2 when compared to a specific reference point (Serway & Jewett, 2004). In The e-MLIST describes objects moving from position one to position two can be described

using a GPS application on the gadget so that we practice IT-based scientific literacy (Figure 5).

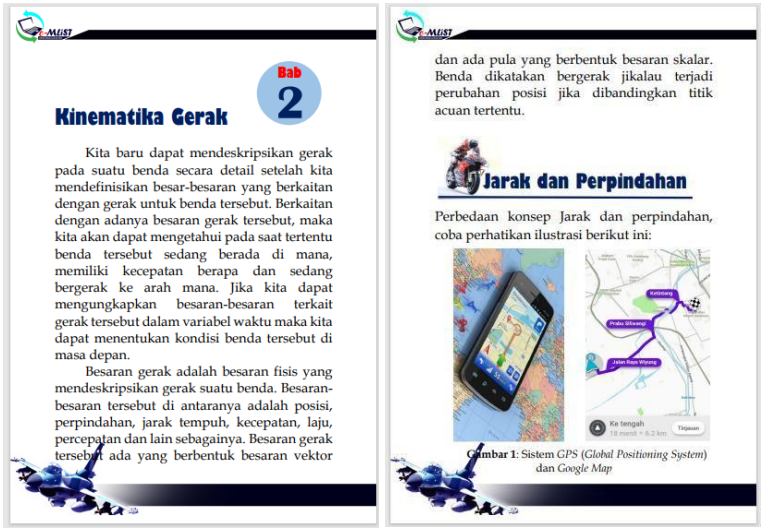


Figure 5. IT-based science literacy training on e-MLIST

In Basic Physics lectures, students are at the initial level of semester one; while explaining the concept of kinematics, they are invited to think and be literate by applying IT. It is to determine the initial position, final position, displacement and distance of moving objects using GPS applications that exist on gadgets so that we instil the concept of kinematics and also train science literacy skills for IT-based students so that lectures are more exciting and varied. In describing the motion of objects, we need a method to describe it, namely the vector method. The initial position and final position

$$\vec{r}_1 = x_1\hat{i} + y_1\hat{j} + z_1\hat{k}$$

$$\vec{r}_2 = x_2\hat{i} + y_2\hat{j} + z_2\hat{k}$$

of a moving object can be described usinga three-dimensional vector (Serway & Jewett, 2004).

Then, the movement of the body is:

$$\Delta\vec{r}_{21} = (x_2\hat{i} + y_2\hat{j} + z_2\hat{k}) - (x_1\hat{i} + y_1\hat{j} + z_1\hat{k})$$

$$= (x_2 - x_1)\hat{i} + (y_2 - y_1)\hat{j} + (z_2 - z_1)\hat{k}$$

Then, the distance could be calculated:

$$\Delta r_{21} = |\Delta\vec{r}_{21}| = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)}$$

Evaluate

Evaluate Validity of e-MLIST

Based on the data analysis results, the Validity of e-MLIST in all Aspects is presented in Figure 4.

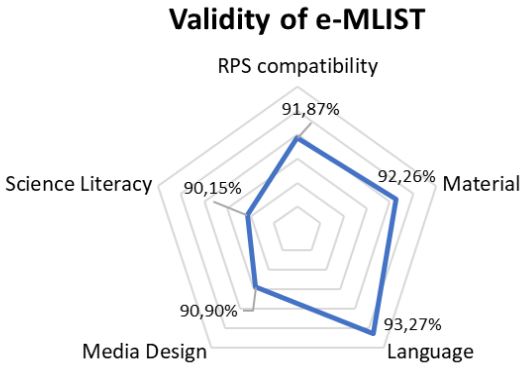


Figure 4. Validity of e-MLIST

Figure 4 illustrates the results of the Validity of the e-MLIST, which has developed motion kinematics material in the Basic Physics One lecture and has an average validity of 91.69% with very valid criteria. According to the e-MLIST Validity diagram of all aspects, the Validity of the scientific literacy aspect has the lowest Validity when compared to other aspects, but the difference is not that big. The scientific literacy aspect needs to be added with features that function to train more scientific literacy so that students are more trained in using scientific literacy skills.

Evaluation of the Practicality of e-MLIST

After the validation of the e-MLIST media was completed and it was stated that the media was very valid, a limited trial was carried out on the PFC 2022 class sample with a total of 27 students so that the practicality of using e-MLIST media in lectures was obtained as shown Figure 5.

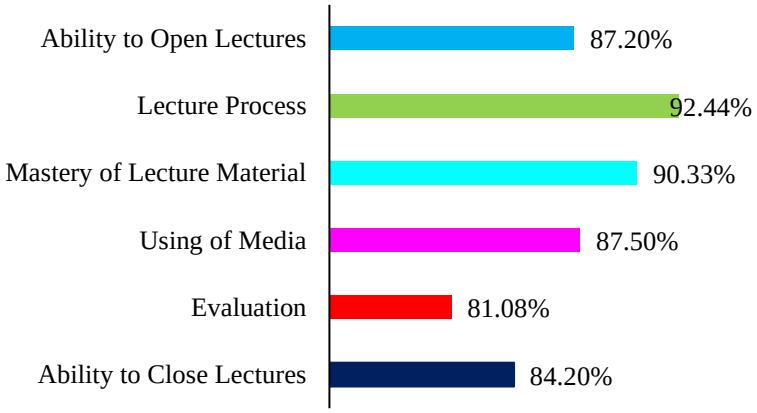


Figure 5. e-MLIST assisted lecture implementation graph

Based on Figure 5. it can be seen that the lectures in basic physics course are carried out very well with an average implementation of 87.13%, this illustrates that lectures by applying e-MLIST can make lectures better and can be used as an alternative IT-based lecture model to train the science literacy skills of entry-level students.

Evaluation of the effectiveness of e-MLIST media

After conducting a limited trial of the use of e-MLIST media in lectures, pre-test and post-test were carried out to determine the improvement of students' science literacy skills, and a graph of the n-Gain criteria was produced as shown in figure 6

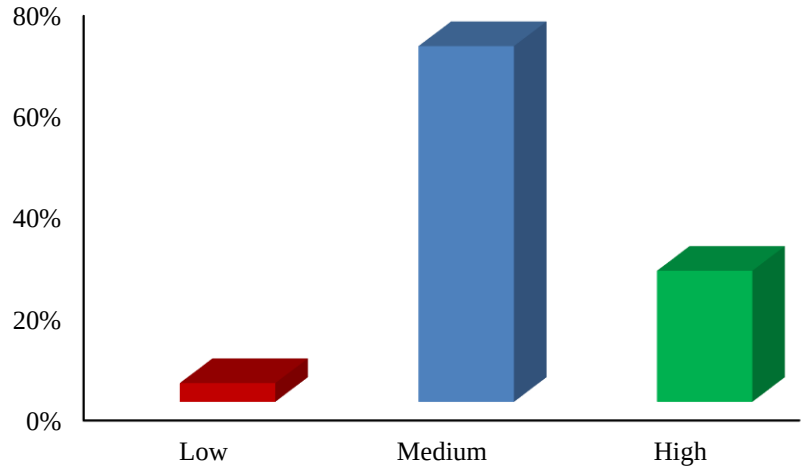


Figure 6. Graph of improving students' science literacy skills (n-gain criteria)

In Figure 6 of the Graph of Improving Students' Science Literacy Skills, it can be seen that there is a significant increase in students' science literacy skills after conducting e-MLIST assisted lectures based on the n-Gain test, an average of n-gain of 0.57 with moderate criteria.

The results of this e-MLIST development research align with previous research (Ravenscroft et al., 2012), which states that learning in the 21st Century is process-oriented learning, problem-solving, adaptability and working effectively and efficiently in different situations. It is because the goal of learning in the 21st Century is to prepare students for the world of Work with a broader scope. The broader scope of Work is due to the very high mobility of humans in times like today. It can be concluded that students must be able to adapt and survive outside their environment well. In other words, the goals of 21st-century learning are shifting to be global. Individuals' demands in the 21st Century should have life skills or both hard skills and soft skills that prepare students for the actual work world and be ready to compete at the Global level. The Core Subjects and Interdisciplinary 21st Century Themes are surrounded by three sets of skills most in demand (1) learning and innovation skills; (2) information, media and technology skills; (3) life and career skills (Trilling & Fadel, 2009).

This research is also in line with the results of the Assessment and Teaching for 21st Century Skills (ATCS), which states four main things related to 21st-century life skills, namely ways of thinking, ways of working, work tools and life skills. The way of

thinking is related to creativity, critical thinking, problem-solving, making the right decisions and learning. The way of working is related to communication and collaborating with others. Information and communication technology (ICT) and information literacy are tools for Work. Life skills are related to living as a citizen, one's life and career, and personal and social responsibility (Trisdiono, 2013). In implementing learning in the 21st Century, 21st-century skills are needed that must be trained in students. Skills required in the 21st Century are problem-solving, critical thinking, communication, collaboration, creativity, information literacy, and various other skills (Ananiadou & Claro, 2009).

In e-MLIST, there are several examples of how good scientific literacy relates to the concept of motion kinematics. The e-MLIST adapts the concept of scientific literacy, which is defined as a person's understanding of physical Science and can apply the physical sciences in social life (Wasis, 2020). The scientific literacy indicators used in the e-MLIST are based on the indicators developed by the OECD, including (a). Explaining phenomena scientifically, (b). They were evaluating and designing scientific investigations, and (c). Interpret data and evidence scientifically (OECD, 2017; Wasis, 2020). One's scientific literacy skills are also directly related to one's higher order thinking skills (HOTS) which have indicators of analysing, evaluating, solving problems, and thinking logically, creatively and systematically (Wasis, 2020). Good scientific literacy skills are also related to higher-order thinking, which requires a person to apply new information or knowledge and manipulate information to reach possible answers in new situations (Brookhart, 2010).

Online-based lectures have the advantage of reducing paper and stationery and being more communicative. Online lectures also have a negative side. Lecturers cannot control student attitudes directly, and students can do some negative characteristics, and direct experience with the natural world is very lacking—for example, the use of laboratory equipment. The basic skills of using laboratory equipment are also lacking. The use of a scientific literacy-based e-module like e-MLIST can be directed to train science process skills such as observing, classifying, analysing, predicting, and communicating. In addition, online learning media can be used to develop several elements of critical thinking and literacy skills, such as analysing, evaluating, applying, generating ideas, and expressing ideas (Kurniawan & Oky, 2014; Irma & Kustijono, 2017; Kustijono & Zuhri, 2018; Wasis, 2020). The results are in line with research that has been carried out by previous researchers on the topic Elite (E-Book Literacy) for Junior High School Student's Scientific Literacy in Solar System Materials, obtaining validity results with very valid criteria and suitable for use as learning media for junior high school students (Kusumawati et al., 2020).

▪ CONCLUSION

Based on the analysis of the data it can be concluded that (1). e-MLIST (scientific literacy-based e-Module) in the Basic Physics course on the topic of motion kinematics that has been developed has Validity with very valid criteria. (2). e-MLIST has an average practicality of 87.13% with excellent criteria. (3). The effectiveness of e-MLIST in lectures has a medium criterion of average n-gain of 0.57. Based on this, it is concluded that the e-MLIST developed is suitable for use in basic physics lectures.

▪ REFERENCES

Ananiadou, K., & Claro, M. (2009). 21st century skills and competences for new millennium learners in OECD countries. *OECD Education Working Papers*, (41), 33. Retrieved from http://dx.doi.org/10.1787/218525261154

Kusumawati, A. T., Wasis, Sanjaya, I. G. M., & Kholiq, A. (2020). Elite (e-book literacy) for junior high school student's scientific literacy in solar system material. *Journal of Physics: Conference Series*, *1491*(1). https://doi.org/10.1088/1742-6596/1491/1/012070

Brookhart, S. M. (2010). How to assess higher order thinking skills in your classroom. Virginia: ASCD.

Fitriani, W., Hairida, & Lestari, I. (2014). Deskripsi literasi sains siswa dalam model inkuiri pada materi laju reaksi di SMAN 9 Pontianak [Description of students' scientific literacy in inquiry model on reaction rate material at SMAN 9 Pontianak]. *Jurnal Pendidikan Dan Pembelajaran, 3 (1),* 12.

International Council of Association for Science Education (ICASE). (2008). Retrieved from http:/www.icaseonline.net.

Gueval, J., Tarnow, K., & Kumm, S. (2015). Implementing e-books: Faculty and student experiences. *Teaching and Learning in Nursing*, *10*(4), 181–185. https://doi.org/https://doi.org/10.1016/j.teln.2015.06.003

Haristy, D. R., Enawaty, E., & Lestari, I. (2014). Pembelajaran berbasis literasi sains pada materi larutan elektrolit dan non elektrolit di SMA Negeri 1 Pontianak [Scientific literacy-based learning on electrolyte and non-electrolyte solutions at SMA Negeri 1 Pontianak]. *Jurnal Pendidikan Dan Pembelajaran*, *2*(12), 27–36.

Irma, Z. U., & Kustijono, R. (2017). Development of android mobile learning using app inventor to train high school student's science process skill. *Inovasi Pendidikan Fisika*, *6*(3), 224–230.

Jaknov, T. P. (2008). Metode penelitian pengembangan [Development Rsearch method].

Kemdikbud. (2017). National literacy movement guide. Jakarta: Kemdikbud.

Kustijono, R., & Zuhri, F. (2018). The use of Facebook and WhatsApp application in learning process of physics to train students' critical thinking skills. *IOP Conference Series: Materials Science and Engineering*, *296*(1). https://doi.org/10.1088/1757-899X/296/1/012025

Liliasari & Fitriana. (2014). Persiapan literasi sains generasi muda Indonesia menjelang Asean Community [Preparation of science literacy for Indonesia's younger generation towards the Asean Community]. Paper Presented at the 2014 Unesa National Seminar.

Martiono, K. T., & Nurhayati, O. D. (2014). Implementation of android-based mobile learning application as a flexible learning media. *International Journal of Computer Science Issues*, *11*(3), 168–174.

OECD. (2019). *PISA*. Paris: OECD Publishing.

OECD. (2017). *PISA*. Paris: OECD Publishing.

Ravenscroft, A., Warburton, S., Hatzipanagos, S., & Conole, G. (2012). Designing and evaluating social media for learning: shaping social networking into social learning? *Journal of Computer Assisted Learning*, *28*(3), 177–182. https://doi.org/https://doi.org/10.1111/j.1365-2729.2012.00484.x

Riduwan. (2015). Skala pengukuran variabel-variabel penelitian [measurement scale of research variables]. Bandung: Alfa Beta

Serway, R. A. & Jewett, J. W. (2004). *Physics for Scientist and Engineers 6th edition*. California: Thomson Brooks/Cole.

Shidiq, A. S., Masykuri, M., & Hayus, E. S. Van. (2014). Pengembangan instrumen penilaian two-tier multiple choice untuk mengukur keterampilan berpikir tingkat tinggi (higher order thinking skills) pada materi kelarutan dan hasil kali kelarutan untuk siswa SMA/MA kelas *XI* [Development of a two-tier multiple choice assessment instrument to measure higher order thinking skills in solubility material and solubility product for students in class XI SMA/MA]. *Jurnal Pendidikan Kimia*, *3*(4), 83–92.

Sudarisman, S. (2015). Memahami hakikat dan karakteristik pembelajaran biologi dalam upaya menjawab tantangan abad 21 serta optimalisasi implementasi kurikulum 2013 [Understand the essence and characteristics of biology learning in an effort to answer the challenges of the 21st century and optimize the implementation of the curriculum 2013]. *Florea : Jurnal Biologi dan Pembelajarannya*, *2*(1), 29–35. https://doi.org/10.25273/florea.v2i1.403

Sugiyono. (2019). Metode penelitian pendidikan [Educational Research Methods]. Bandung: Alfabeta.

Tegeh, I. M. & Kirna, I. M. (2012). Metode penelitian pengembangan pendidikan [Educational Development Research Methods]. Singaraja: Graha Ilmu.

Trilling, B., & Fadel, C. (2009). 21st century skills: Learning for life in our times. Hoboken: Jossey-Bass/Wiley.

Trisdiono, H. (2013). Lembaga penjaminan mutu pendidikan propinsi d.i yogyakarta [Yogyakarta Provincial Education Quality Assurance Institute].

Wasis, Rahayu, Y. S., Sunarti, T., & Indana, S. 2020 *HOTS* dan Literasi Sains: Konsep, Pembelajaran dan Penilaiannya [HOTS and Science Literacy: Concepts, Learning and Assessment]. Jombang: Kun Fayakun.

Yager, R. E. (2000). A Vision for what science education should be like for the first 25 years of a new millennium. *School Science and Mathematics*, *100*(6), 327–341. https://doi.org/https://doi.org/10.1111/j.1949-8594.2000.tb17327.x