

The Effect of Research-based Digital Module towards Students' Science Literacy Ability in Static Fluid Materials

Tia Rachma Fajaryanti and Erina Hertanti*

UIN Syarif Hidayatullah Jakarta, Jakarta, Indonesia

*erina.hertanti@uinjkt.ac.id

DOI:10.20527/bipf.v10i2.12781

Received: 20 February 2022 Accepted: 30 June 2022 Published: 1 October 2022

Abstract

The main problem of this study is the implementation of physics learning activities that do not involve the scientific process that can train students' science literacy ability, especially in the competence aspects. As a result, the development of students' science literacy ability is not maximal. A solution given in this study is a research-based digital module as teaching material. This study was conducted at SMA Dharma Karya UT with a quasi-experimental method and nonequivalent control group design. The study used purposive sampling to decide the study's sample with the following classification XI IPA 2 as the experimental class with 25 samples and XI IPA 1 as the controlled class with 25 samples. The instruments of the study were test and non-test. The science literacy test contained ten questions, and the non-test was a questionnaire. In addition, based on a statistical calculation of the post-test by using a nonparametric test, Mann-Whitney showed that a significant score 2-tailed ($0.011 < \text{significant level } (\alpha=0.05)$). It showed a research-based digital module's effect on students' science literacy ability. Meanwhile, the result of N-Gain showed the enhancement of students' science literacy ability; this can be seen from the superior N-Gain value in the experimental class. Moreover, the questionnaire also showed that using research-based digital modules for students' science literacy ability was good (73%).

Keywords: Competence Aspects; Fluid Static; Research-Based Digital Module; Science Literacy Ability

© 2022 Berkala Ilmiah Pendidikan Fisika

How to cite: Fajaryanti, T. R., & Hertanti, E. (2022). The effect of research-based digital module towards students' science literacy ability in static fluid materials. *Berkala Ilmiah Pendidikan Fisika*, 10(2), 199-206.

INTRODUCTION

Science mastery is one of the student's abilities that must be prepared to face scientific development challenges. Science mastery ability is related to literacy (Irsyan et al., 2013). Science literacy is an ability to engage issues and ideas related to science (OECD, 2015). Science development can only be achieved with science literacy (Liu, 2009). Students with science literacy ability can be expected to

enhance their caring for themselves and the environment (Setyaningtyas, 2018). It can be concluded that science literacy is crucial for students to understand their environment and other problems related to science development (Ahmad; Enawaty, Eny, & Lestari, 2018).

However, the average ability of students' science literacy in Indonesia is lower than in other countries. It is stated in the science literacy study PISA (Programme for International Student

Assessment) that was done by OECD (Organization for Economic Co-Operation and Development) and Unesco Institut for Statistics, stated in 2018 that Indonesia's science literacy ranked 70 of 78 participating countries with an average score 396 points of the highest score 590 points (OECD, 2019). It shows that students' science literacy achievement is far below the average score of other members of PISA. The lack of science literacy makes the nation's generation prone to mistakes, mainly in understanding facts and discovering science (Mukti et al., 2019).

Some factors make students' science literacy ability in Indonesia low. According to Naturasari et al. (2016), the lack of learning activity involves scientific processes such as doing a scientific investigation, explaining natural phenomena using our capability, and concluding the facts based on research. On the other hand, according to Novili et al. (2016), it is caused by the lack of curriculum implementation that can train students to design scientific research. Practical implementation faces inadequate laboratory facilities (Limatahu et al., 2017). Based on an interview with the Physics teacher of SMA Dharma Bakti, UT said that science literacy had been implemented in the class, but, constrained by nonoptimal practical implementation, so that students do not know how to process, read, and present data. It means that practical activity is needed to develop students' science literacy ability since it involves students' competence (Ahmad; Enawaty, Eny, & Lestari, 2018). Nevertheless, according to Andriani & Ismet (2017) it is caused by the implemented teaching materials being more focused on contents instead of processes (competencies), which is what PISA concern. In conclusion, some factors that make Indonesia's science literacy ability low are the lack of learning processes involving science

processes, practical activity, and nonoptimal learning materials. Therefore, this study will implement a solution to make research-based digital modules as learning material to overcome the problem.

The research-based digital module is a digital module which contains research-based learning components. Research-based learning components consist of background problems, research procedures, research implementation, research results, discussion, and publication of research results (Widayati, 2010). The components in this research-based digital module are expected to improve students' ability to build knowledge, increase student activity and curiosity, and train students to solve problems by looking at the facts they gain (Usmeldi, 2016). Research-based digital modules can be applied to subjects that require practical activities, such as Physics (Usmeldi, 2016). A physics material with many practical activities in its learning is static fluid (Nurfatima, 2015). Therefore, the research-based digital module in this study is applied to static fluid materials. The choice of static fluid material is based on several reasons. First, static fluid material is one of the materials that require research or practical activities to improve understanding of concepts (Nurfatima, 2015). Second, learning static fluid material can be done by providing a real experience so that students can build a complete understanding of the concept (Husain et al., 2018). Third, static fluid material can be applied in scientific literacy content based on PISA considerations to apply knowledge and skills in different content aspects and to analyze, reason, scientific attitude, solve and conclude real-life problems (Widodo et al., 2018). Fourth, according to Nurfatimah's research results, static fluids can be applied to research-based learning models (Nurfatima, 2015).

The research-based digital module design in this study consists of three parts, namely the opening part, the core part, and the closing part. The module presents concept maps, core competencies, basic competencies, indicators, learning objectives, and instructions in the opening part. In the core part, the module is designed based on the components of a research-based learning model.

The first component is the background of the problem; the research-based digital module presents problems in the form of video and pictures to stimulate students to find solutions when faced with a scientific problem. For example, differentiating the water pressure of a child swimming in a river from a child swimming in the sea. The second component is research procedures, in which research-based digital modules provide information related to research steps that will help students formulate hypotheses and determine variables in research (Rahim, 2019). The third component is research implementation. In research-based digital modules, practical activities are presented in digital form (virtual lab) to facilitate research implementation. The fourth component is research results; in research-based digital modules, a column is presented to enter data and describe data from the results of research implementation. The fifth component is discussion; in research-based digital modules, a column is presented to write a discussion of research results that have been adapted to theory. The sixth component is the publication of research results; in research-based digital modules, instructions are provided to motivate students by presenting research reports in front of the class. In the closing part, the research-based digital module presents a summary of the core material, scientific literacy practice questions, and a glossary containing foreign terms that students do not know.

Such research-based digital module designs are expected to improve students' ability to build knowledge, increase activity and curiosity, and train students to solve problems by looking at the facts they encounter. These abilities are expected to help students improve their scientific literacy skills. Therefore, it is important to express this rationale through a study entitled the effect of research-based digital module on students' scientific literacy ability in static fluid material.

METHOD

This study used a quasi-experimental method. It aims to know the effect of implementing a certain action towards a certain condition (Sanjaya, 2013). The process of this study is illustrated in Figure 1.

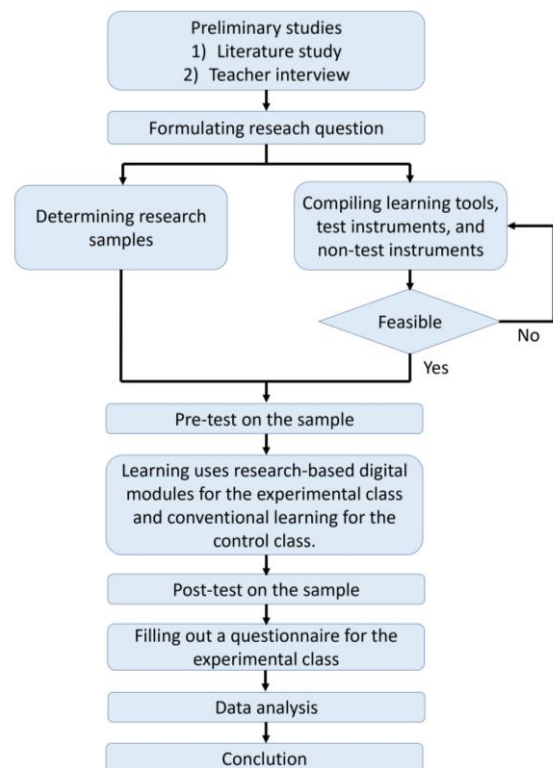


Figure 1 Flowchart of The Study Process

This study used a pretest-posttest nonequivalent control group design. This design involves two classes: the

controlled and experimental classes, which are not chosen randomly (Sugiyono, 2011). The experimental class was given treatment with a research-based digital module, while the controlled class was treated with a conventional teaching method.

The data were collected by using a science literacy test and questionnaire. A science literacy test was given to both classes with ten questions. Meanwhile, the experimental class gave the questionnaire after the treatment was implemented. The data were analyzed using the analysis prerequisite test and

hypothesis test (SPSS) 23. Analysis prerequisite test has two requirements: normality and homogeneity tests, which aim to consider what appropriate formula can be used in the hypothesis test. In addition, a hypothesis test was used to know the effect of research-based digital modules significantly towards students' science literacy ability in a static fluid material.

RESULT AND DISCUSSION

The results of the pre-test and post-test in the experimental class and control class can be seen in Table 1.

Table 1 Recapitulation Result of Pre-Test and Post-Test of Experimental and Controlled Class

Data Centralization and Dissemination	Pretest Score		Posttest Score	
	Experimental Class	Controlled Class	Experimental Class	Controlled Class
The lowest score	18	18	48	35
The highest score	50	53	78	70
Mean	34.88	35.56	58.84	51.6
Modus	38	33	55	45
Median	35	35	55	53
Standard of Deviation	8.852	7.200	9.286	8.456

Table 1 shows that before being given treatment, the average score on pre test of scientific literacy ability in the experimental class (34.88) was lower than the control class (35.56). However, after being given different treatments, the average score of post-test of scientific literacy ability in both classes increased. The average score of the experimental class science literacy ability (58.84), which was treated with research-based digital module learning, was higher than the average score of the post-test of the controlled class (51.60), which was treated with conventional learning. This is in line with the research results of Nurfatima et al., that the average score of students who use research-based learning is higher than conventional learning (Nurfatima, 2015).

Analysis of pre-test and post-test data in the experimental and control classes based on scientific literacy skills can be seen in Figure 2.

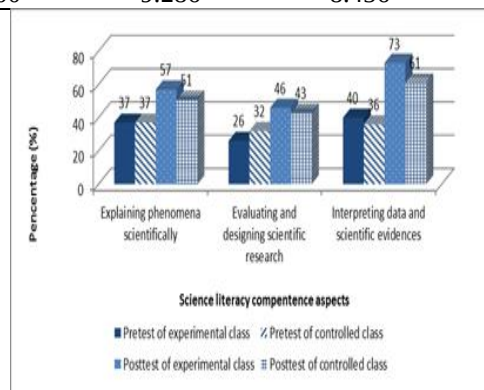


Figure 2 Diagram of Pre-Test and Post-Test Results of Students' Science Literacy of Experimental and Controlled Class

Figure 2 shows that both the experimental class and the control class as a whole experienced an increase. The highest increase for both classes is in interpreting data and scientific evidence (33% and 25%). In the diagram above, it

can be seen that the aspect of competence that experienced the lowest increase in the control class was evaluating and designing scientific research (11%), while in the experimental class occurs in two

competencies are explaining phenomena specifically and evaluating and designing scientific research (20% each).

The result of the normality test pre-test and post-test are shown in following Table 2.

Table 2 Result of Normality Test of Pre-Test and Post-Test of Experimental and Controlled Class

Statistic	Pre-test		Posttest	
	Experimental Class	Controlled Class	Experimental Class	Controlled Class
Df	25	25	25	25
Sig.(2-tailed)	0.289	0.613	0.029	0.885
Significance level (α)	0.05		0.05	
Conclusion	Normally distributed data	Normally distributed data	Abnormally distributed data	Normally distributed data

The results of the homogeneity test can be seen in Table 3.

Table 3 Result of Homogeneity Test of Pre-Test and Post-Test of Experimental and Controlled Class

Statistic	Pre-test of an experimental and controlled class	Post-test of an experimental and controlled class
Levene Statistic	0.897	0.595
Sig.(2-tailed)	0.348	0.444
Significance Level (α)	0.05	
Conclusion	Both classes are homogenous	Both classes are homogenous

Based on normality and homogeneity test shows that pre-test and post-test are normally distributed and have the same various data. Therefore, a T-test is used to analyze the hypothesis. Moreover, the experimental and controlled class post-test results are abnormally and normally distributed data. However, both classes have the same various data. Therefore, hypothesis testing was carried out using a nonparametric statistical analysis of the Mann Whitney test. The results of hypothesis testing can be seen in Table 4.

Table 4 Hypothesis Test Result Of Pre-Test and Post-Test of Experimental and Controlled Class

Statistic	Pre-test (T-test)	Posttest (Mann-Whitney test)
Sig.(2-tailed)	0.348	0.011
Significance Level (α)	0.05	
Conclusion	H_0 is accepted	H_a is accepted

Table 4 shows that the pre-test results have a value of Sig. (2-tailed) > 0.05. It

This means that the null hypothesis is accepted and the alternative hypothesis is rejected; in other words, before being given treatment, there is no effect on students' science literacy ability. Meanwhile, post-test results have a value of Sig. (2-tailed) < 0.05 . It means the null hypothesis is rejected, and the

alternative hypothesis is accepted. In other words, there is a significant increase in students' science literacy ability after being given the treatment using a research-based digital module. The N-Gain result of students' science literacy ability in experimental and controlled classes can be seen in Table 5.

Table 5 The N-Gain of Students' Science Literacy of Experimental and Controlled Class

Competence Aspects	Experimental Class		Controlled Class	
	N-Gain	Category	N-Gain	Category
Explaining phenomena scientifically	0.32	Medium	0.21	Low
Evaluating and designing scientific research	0.27	Low	0.15	Low
Interpreting data and scientific evidence	0.55	Medium	0.40	Medium

Based on Table 5 shows that there is an increase in students' science literacy ability for both classes in each competence aspect. In the experimental class, two aspects of competence have increased with a medium category (explaining phenomena scientifically; interpreting scientific data and scientific evidence) and one aspect of competence with a low category (evaluating and designing scientific research). Meanwhile, in the controlled class, one aspect of competition has increased in the medium category (interpreting scientific data and scientific evidence) and two aspects of competence in the low category (explaining phenomena scientifically; evaluating and designing scientific research).

The experimental class is better than the controlled class in the aspect of competence to explain phenomena scientifically. This is because research-based digital modules present pictures and videos about scientific phenomena that students often encounter daily (Novili et al., 2016). Presentation of phenomena can provide real experience for students to develop competencies in order to be able to understand nature scientifically (Husain et al., 2018). In addition, providing real experience is

also done by presenting a case related to the real world. The presented case invites students to solve problems by looking at the facts they encounter (Usmeldi, 2015). According to Husain et al., providing real experiences can instill the ability to understand fully and more deeply and equip students to apply the concepts they have in solving problems (Husain et al., 2018). Usmeldi (2016) stated that solving problems from a case can train students' ability to explain phenomena scientifically. This is supported by the questionnaire results that 72% of students disagreed that presenting cases in research-based digital modules made it difficult to explain phenomena scientifically.

The aspect of competence in evaluating and designing scientific investigations requires students to carry out investigative activities (OECD, 2017). In research-based digital modules, an effort to invite students to conduct investigations is to present information related to practicum procedures. According to Emda (2014), presenting practicum procedures can train students to determine fixed and changing variables, tools and materials, and practical work steps to improve their ability to design scientific investigations.

In addition, scientific investigations are also carried out in experimental activities, such as practicum (Tatar & Oktay, 2011). In research-based digital modules, an effort to invite students to do practical work is to present a virtual lab. A virtual lab (practicum) presentation can train scientific thinking skills and solve problems encountered to improve students' science process skills (Lepiyanto, 2014). Science process skills are a tangible manifestation of the ability to evaluate scientific investigations (Usmeldi, 2016). If viewed based on the results of the questionnaire, 76% of students stated that presenting a virtual lab on a research-based digital module could train them to design an investigation.

The results of N-Gain show that competence in evaluating and designing scientific investigations is categorized as low, both in the experimental and controlled classes. In the experimental class, there are obstacles to implementing online learning. The problem is that some students do not have a laptop that supports the operation of research-based digital modules, so learning is carried out by observing demonstrations in online study rooms. In addition, the competence aspect of evaluating and designing scientific investigations is also included in the very difficult category (Novili et al., 2016). The ability of students in the competence aspect of evaluating and designing scientific investigations is the lowest among other competency aspects (Novili et al., 2016).

The aspect of competence in interpreting

scientific data and evidence require students to interpret the meaning of scientific evidence and use diagrams or other appropriate representations (OECD, 2017). In the research-based digital module, an effort to invite students to represent data is to present a practicum data Table. The students will find it easier to represent data in other forms by understanding the practicum data Table (Novili et al., 2016). This is supported by the results of the questionnaire that 70% of students disagreed that the presentation of observation Tables on research-based digital modules made it difficult to represent practicum data. In addition, the meaning of scientific evidence can also be interpreted in the form of words that can describe a clear relationship between scientific evidence and conclusions (Zuriyani, n.d.). In the research-based digital module, an effort to invite students to interpret scientific evidence in the form of words is to present a discussion column. According to Fanny et al., the written discussion must be adjusted between the practicum data obtained and the related theory. The students who can represent data and draw conclusions in the form of discussions correctly could solve problems that require aspects of competence to interpret data and scientific evidence (Rohmi, 2017).

Overall, using research-based digital modules during the online learning process received a positive response from students. The results of the questionnaire prove it, as seen in Table 6.

Table 6 Analysis Result of Students' Responses to The Implementation of Research-Based Digital Module

No	Questionnaire Indicators	Percentage (%)	Category
1	The implementation of a research-based digital module in the learning process	74	Good
2	The effect of research-based digital modules towards students' science literacy ability	73	Good
Average		73.5	Good

Table 6 shows that the use of research-based digital modules on scientific literacy skills is in a good category (73%). In addition, research-based digital modules are teaching materials that can improve students' science literacy ability. It is proven from the results of N-Gain that there is an increase in the aspects of students' science literacy competence (explaining phenomena scientifically, evaluating and designing scientific investigations, interpreting scientific data and scientific evidence). This means that using research-based digital modules can positively impact students' science literacy ability in static fluid materials.

CONCLUSION

In conclusion, the research-based digital module affects students' science literacy in the static fluid. It can be seen on the statistical hypothesis testing of post-test that Sig. 2-tailed (0.011) < significance level (0.05). In addition, the N-Gain result shows an enhancement in students' science literacy (explaining phenomena scientifically: evaluating and designing scientific research: interpreting data and scientific evidence). Moreover, the questionnaire results show that using the research-based digital module in learning is in good category (73%).

REFERENCE

- Ahmad, A., Enawaty, E., & Lestari, I. (2018). Deskripsi kemampuan literasi sains siswa kelas XII IPA 1 di SMA mujahidin Pontianak pada materi larutan asam basa. *Artikel Penelitian Program Studi Pendidikan Kimia FKIP Untan Pontianak*, 2-11.
- Andriani, N., & Ismet, I. (2017). Analisis kategori literasi sains untuk konten fisik pada buku siswa mata pelajaran IPA kelas VII SMP/MTs. *Prosiding Seminar Nasional Pendidikan IPA*, 664.
- Emda, A. (2014). Laboratorium sebagai sarana pembelajaran kimia dalam meningkatkan pengetahuan dan keterampilan kerja ilmiah. *Latanida Journal*, 2(2), 224.
- Husain, M. S., Kendek Y., & Fihirin, F. (2018). Analisis tingkat pemahaman konsep fluida statis dan penerapannya di lingkungan sekitar pada siswa SMA negeri 2 Palu. *Jurnal Pendidikan Fisika Tadulako Online*, 6(1), 22.
- Lepiyanto, A., (2014). Analisis keterampilan proses sains pada pembelajaran berbasis praktikum. *Bioedukasi*, 5(2), 159.
- Limatahu, N. A., Rahman, N. A., Abu, St. H. N., & Cipta, I. (2017). Pengaruh video praktikum dengan modul elektronik terhadap keterampilan proses pada materi stoikiometri siswa kelas X MAN 2 Tidore Kepulauan. *Jurnal Pendidikan Kimia (JPKim)*, 9(1), 225.
- Liu, X. (2009). Beyond science literacy: science and the public. *International Journal of Enviromental & Science Education*, 4(3), 301.
- Mukti, W. R., Yuliskurniawati, I. D., Noviyanti, N. I., Mahanal, S., & Zubaidah, S. (2019). A survey of high school students' scientific literacy skills in different gender. *The International Seminar on Bioscience and Biological Education*, 2-6.
- Naturasari, H., Roshayanti F., & Nurwahyunani, A. (2016). Profil kualitas literasi sains siswa SMP se-kabupaten Pati. *Bioma*, 5(2), 8.
- Novili, W. I., Utari, S., & Saepuzaman, D. (2016). Penerapan scientific approach untuk meningkatkan literasi saintifik dalam domain kompetensi siswa SMP pada topik kalor. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, 2(1), 52-54.
- Nurfatima, A. S., & Subaer, S. (2015). Pengaruh metode pembelajaran berbasis riset pada materi fluida statis terhadap hasil belajar fisika Kelas XI madrasah aliyah madani alaiddin.

- Prosiding Pertemuan Ilmiah XXIX HFI Jateng & DIY*, 96-97.
- OECD. (2015). Draft science framework. *OECD Publishing*, Paris.
- OECD. (2017). PISA 2015 Assessment and analytical framework: science, reading, mathematic, financial literacy and collaborative problem solving (revised edition). *OECD Publishing*, Paris.
- OECD. (2019). PISA 2018 Results (Combined Executive Summaries Volume I, II & III). *OECD Publishing*, Paris.
- Rahim, F. R. (2019). Implementasi research based learning (RBL) pada mata kuliah IPA terpadu di program studi pendidikan fisika. *Jurnal Eksakta Pendidikan (JEP)*, 3(1), 84-90.
- Rohmi, P. (2017). Peningkatan domain kompetensi dan pengetahuan siswa melalui penerapan level of inquiry dalam pembelajaran IPA terpadu. *Edusains*, 9(1), 19.
- Sandi, M. I. (2013). Analisis buku ajar fisika SMA kelas X di kota Bandung berdasarkan kategori literasi sains. *Prosiding Seminar Nasional Fisika*, 3, 7.
- Sanjaya, W. (2013). *Penelitian pendidikan: Jenis, metode, dan prosedur*. Jakarta: Kencana, 87-248.
- Setyaningtyas, R. F., Sarwanto., & Prayitno, B. A. (2018). Pengembangan modul IPA tema energi listrik berbasis guided discovery untuk meningkatkan literasi sains. *Media Prestasi*. XVIII (1), 113.
- Sugiyono, S. (2011). *Metode penelitian kuantitatif kualitatif dan R&D*. Bandung: Alfabeta.
- Tatar, E., & Münir O. (2011). *The effectiveness of problem-based learning on teachiing the first law of thermodynamic*. Routledge, London: UK, 325.
- Usmeldi, U. (2015). Pengembangan lembar kerja siswa dalam pembelajaran fisika berbasis riset di SMAN 1 Padang. *Prosiding Seminar Nasional Fisika (E-Journal) SNF2015*, IV, 186.
- Usmeldi. (2016). Pengembangan modul pembelajaran fisika berbasis riset dengan pendekatan scientific untuk meningkatkan literasi sains peserta didik. *JPPPF - Jurnal Penelitian & Pengembangan Pendidikan Fisika*, 2(1), 2-3.
- Widayati, D. T., Luknanto, D., Rahayuningsih, E., Sutapa, G., Harsono., Sancayaningsih, R. P., & Sajarwa. (2010). *Pedoman umum pembelajaran berbasis riset (PUPBR)*. UGM, 4.
- Widodo, L., Lia Y., & Parno, P. (2018). Scientific literacy materi fluida statis siswa SMA: studi kasus. *Jurnal Riset dan Kajian Pendidikan Fisika (JRKPF) UAD*, 5(1).
- Zuriyani, E. *Literasi Sains dan Pendidikan*. Diperoleh dari <https://sumsel.kemenag.go.id/files/sumsel/file/file/TULISAN/wagj1343099486.pdf>.