JPF | Volume 12 | Number 1 | 2024 | 14 - 22

p - ISSN: 2302-8939
e - ISSN: 2527-4015

Jurnal Pendidikan Fisika

https://journal.unismuh.ac.id/index.php/jpf

DOI: 10.26618/jpf.v12i1.11756

Improving Student Science Literacy Skills Through the Use of Teaching Materials with Socioscientific Contexts on Newton's Gravity Material

Asep Saefullah[1)*] Diana Ayu Rostikawati[2)]

[1)]Physics Education Department, Universitas Sultan Ageng Tirtayasa, Serang 42117, Indonesia
[2)] Primary Teacher Education Department, Universitas Bina Bangsa, Serang 42124, Indonesia

**Corresponding author: asaefullah@untirta.ac.id*

Received: July 23, 2023; Accepted: October 17, 2023; Published: January 11, 2024

Abstract *– This research was motivated by the frequent appearance of news about social issues, such as tidal floods caused by eclipses, which are linked to Newton's theory of gravity. A teaching material was developed that integrated the issue of tidal flooding with physics concepts. The study aimed to determine how scientific literacy among students is influenced by using teaching materials in the context of socioscientific issues. The research methodology was quasi-experimental, utilizing a pretest-posttest design with one group. The study was conducted in the Physics Education Department at Sultan Ageng Tirtayasa University in Serang, Indonesia. The research sample consisted of fifty "Physics Education" majors enrolled in Fundamental Physics I. A scientific literacy test instrument was used as the research tool, and professional validation of the instrument yielded a validation score of 82.45%. The study concluded that teaching materials focused on socioscientific issues related to Newton's theory of gravity positively impacted students' scientific literacy skills. The students' scientific literacy showed an increase of 0.34, categorized as a moderate improvement.*

Keywords: *newtonian gravity; scientific literacy; socio-scientific issues*

I. INTRODUCTION

Physics, a science investigating natural events, can identify natural wonders by monitoring these symptoms (Harefa, 2019). Over the past two years, natural disasters specifically, tidal floods have frequently caused problems for the community because of occultations (Nugraha et al., 2015). Changes in sea level brought on by space matter's attraction to Earth's oceans particularly the moon and sun cause coastal flooding. (Hidayati, 2017; Ilyas et al., 2019).

Tidal floods arise from sea tides triggered by Newton's gravity (Heydel et al., 2017). The tides are the seawater movement brought about by the gravitational force between the mass of Earth and the masses of other celestial bodies, especially the sun and moon (Hasanudin et al., 2016). A gravitational tidal bulge forms when

gravity draws saltwater towards the moon and sun (Erssal, 2020). Newton's gravity is one of the materials in the Fundamental Physics 1st course in all physics education study programs (Yefremov & Vorobyeva, 2021). Understanding and observing these phenomena is needed in learning physics, including scientific literacy (Kusjuriansah & Yulianto, 2019).

The intersection of natural science and social issues is known as socio-scientific issues. SSI is a problematic, contentious problem and needs a definitive solution. Instead, the solution is up for debate (Rostikawati & Permanasari, 2016; Gurses et al., 2015; Foong & Daniel, 2010). The connection between societal difficulties and Newton's gravitational substance is depicted in Figure 1.

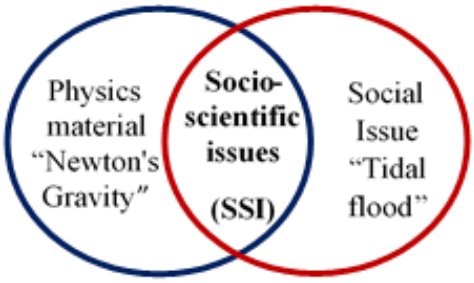

Figure 1. The intersection between Newton's gravitational material and the social issue of tidal flooding

Many studies related to SSI have been carried out; for example, SSI research on the chemistry curriculum (Gulacar et al., 2022), SSI research on elementary school teachers (Genisa et al., 2020), SSI research on the theme of nuclear power plants (Jho et al., 2014). Previous research also stated SSI can be developed through teaching materials (Genisa et al., 2020). In addition, the use of SSI in the context of science learning can promote scientific literacy abilities (Ke et al., 2021).

The ability to obtain information by recognizing and formulating assumptions based on scientific facts is known as scientific literacy, and it is based on scientific understanding and knowledge (Saefullah et al., 2017; Handayani, 2019). However, according to Puspendik's data, Indonesia is rated first from the bottom out of the 79 countries that participated in the most recent PISA results from 2018 (OECD., 2019). The variety of textbooks available to pupils is one of the things causing their inadequate scientific literacy (Fuadi et al., 2020). Teaching materials in book form support students' scientific literacy skills (Rostikawati & Saefullah, 2022). Widely used textbooks require more context-based learning and direct instruction.

Using the SSI approach to restructure instructional materials that promote and educate scientific literacy is one way to address these problems (Sadler et al., 2017). Teaching Newton's gravity material in the context of socio-scientific issues has been compiled into four chapters, including the definition of tidal floods, the causes of tidal floods, Newton's law of gravity with tidal floods, and tidal flood mitigation (Zahura & Goodall, 2022).

The research results of Nazilah et al. (2019) show that the reconstruction of teaching resources can surge scientific literacy

in the context of SSI. Research conducted by Saefullah et al. (2021) states that using SSI teaching materials affects scientific literacy skills. In practice, the SSI method supports achieving critical thinking skills, understanding knowledge concepts of the Nature of Science (NOS), and scientific literacy (Zeidler et al., 2019).

To achieve this goal, research must be done on employing instructional materials on Newton's law of gravity in the context of socio-scientific challenges to raise students' scientific literacy.

II. METHODS

Types of research

Experimental research is the methodology employed. Pre-post group design and quasi-experimental research methodology were employed in this study (Nasar & Kaleka, 2019). This study's design included a single experimental class that received instruction (Sugiyono, 2013), namely by using teaching materials in the SSI context, as shown in Figure 2.

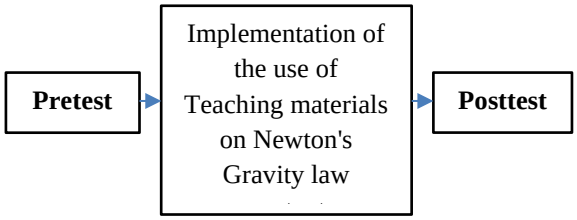

Figure 2. Research Design

Research subject

The subjects in this study were 50 students majoring in physics education at Sultan Aegng Tirtayasa University, Serang, Indonesia, who were taking a Fundamental Physics course 1. Selection of research subjects using a simple random sampling technique

Method of collecting and analyzing data

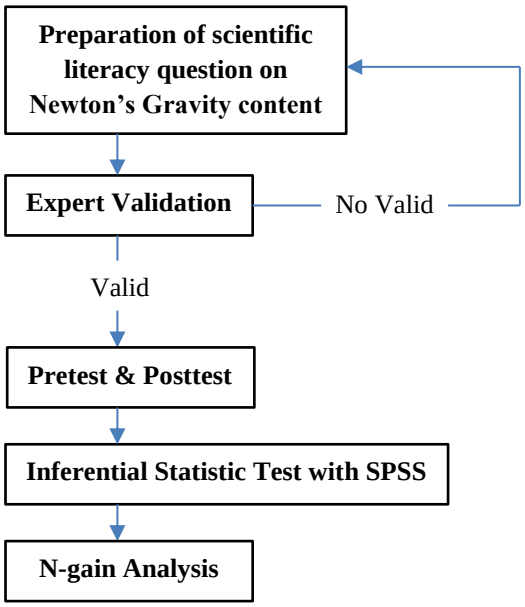

Figure 3. Collecting and analyzing data

A test instrument for scientific literacy questions was the research tool utilized in this study (Purwanto, 2019). Students are given scientific literacy questions for pretest and posttest purposes. Ten multiple-choice questions with answers about scientific literacy. Expert validation in a suitable category has validated the test instrument used.

The steps for analyzing the results of the competency aspect of the scientific literacy test on gravity material are carried out in the following way: (1). Pretest and posttest scoring. (2) The test, known as the Inferential

Statistics Test, is administered using the SPSS software. (3) Calculation of normalized gain (n-gain) (Wahab et al., 2021).

III. RESULTS AND DISCUSSION

The first product of this research is the development of educational resources that may be utilized to improve learning in the SSI context. Five stages were carried out during the development process: analysis, design, development, implementation, and evaluation of (ADDIE).

Experts have validated the shaped instructional resources, and with an average score of 89.50, they fall within the excellent category. Figure 4 shows the product cover of Newton's gravity teaching material with the SSI context that has been produced.

Figure 4. Cover of Newton's gravity teaching materials by the SSI context

The implementation of teaching materials within the context of Socio-Scientific Issues (SSI) on Newton's Law of Gravity significantly enhanced students' scientific literacy skills. This research specifically focused on the competency aspect of scientific literacy by using SSI-based teaching materials, students were encouraged to engage with real-world issues, fostering deeper understanding and critical thinking in relation to Newton's gravity concept.

The data analysis process began with the collection and processing of both pretest and posttest scores to assess the impact of the instructional approach on students' literacy. These assessments provided insight into the students' baseline abilities and the progress made after the intervention. Table 1 presents the processed data, showcasing the improvement in scientific literacy skills between the pretest and posttest results. The substantial increase in scores suggests that integrating SSI into teaching materials not only helped students grasp the content more effectively but also developed their overall competency in scientific literacy, emphasizing the importance of applying scientific concepts to societal issues. This method proves to be an effective approach to fostering a deeper, more contextual understanding of science among students.

Table 1. Science literacy score

Data	Science literacy score		
	Min.	Max.	Average
Pretest	38	64	56
Posttest	54	88	74

In the pretest, the science literacy scores ranged between 38 (minimum score) and 64 (maximum score), with an average of 56. After the posttest, there was an improvement in the science literacy scores, with the minimum score increasing to 54, the maximum score reaching 88, and the average rising to 74.

From this data, a significant improvement can be observed in the participants' science literacy scores after the intervention or learning process. This indicates that the intervention was effective in enhancing the participants' science literacy.

The second step in analyzing research data is to determine the normality of research data. The results of testing the normality of research data can be seen in Table 2.

Table 2. Normality test calculation results

Data Source	Shapiro-wilk			
	Statistics	**N**	**Sig.**	**Distribution**
Pretest	0.964	50	0.21	Normal
Posttest	0.958	50	0.12	Normal

Based on Table 2 using the Shapiro-Wilk method, it can be concluded that both pretest and posttest data have a normal distribution. The normality test is conducted to determine whether the data in a sample follows a normal distribution, which is a crucial assumption for parametric statistical analysis.

In the pretest normality test results, the Shapiro-Wilk value is 0.964, with a sample size (N) of 50 and a significance value (Sig.) of 0.21. Since the significance value is greater than 0.05, the pretest data is considered to be normally distributed. This indicates that the variation in pretest scores among participants tends to spread normally or is close to a normal distribution.

Similarly, the posttest normality test results show a Shapiro-Wilk value of 0.958, with the same sample size (N = 50) and a significance value of 0.12. Since this significance value is also greater than 0.05, the posttest data is also considered normally distributed.

The normality test computations show that the pretest and posttest data are typically distributed. Because the data is normally dispersed, the normality test results serve as a guide for the next test, which is the hypothesis test. The statistical test utilized is the paired sample t-test.

The SPSS program's hypothesis testing findings showed a significance level of (α) = 0.00 <0.05, indicating that employing instructional materials on Newton's gravity content in the SSI context disrupts students' scientific literacy skills.

After the impact of using instructional materials in the SSI environment has been determined, the next step is to ascertain the increase in scientific literacy among students. Based on the pretest and posttest results, the n-gain equation is used to examine how much the students' scientific literacy has increased. A diagram of improving pupils' scientific literacy skills is presented in Figure 5.

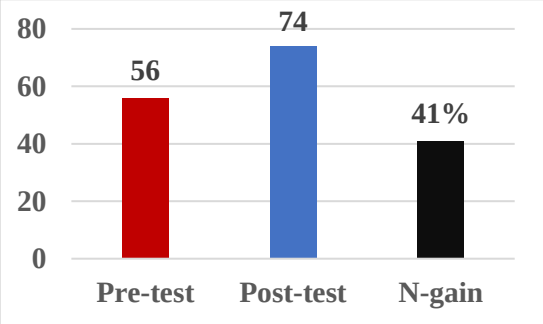

Figure 5. Pretest, posttest and n-gain scores.

Instructional resources with the SSI context on Newton's law of gravity content were used in the learning process, resulting in a 41% increase in scientific literacy in the medium category.

Increasing scientific literacy through using teaching materials in the SSI context is also supported by the results of research showed by Saefullah et al. (2021), which stated that SSI-based learning can increase scientific literacy. Using teaching materials in the SSI context can help students become responsible citizens because SSI-based learning prepares students to study and research social issues related to science (Presley et al., 2013; Espeja & Couso, 2020).

The results of another study directed by Rubini et al. (2019) showed that using SSI increases students' scientific literacy. SSI is the implication of morals and ethics. Therefore, promoting scientific literacy requires SSI-based learning (Rohmah et al., 2022). SSI provides a way to explore NOS, a bridge between students and scientific literacy, a link between science and society, and democratizing science in society. The surge in students' scientific literacy, which is quite good, is closely related and directly proportional to students' responses to the quality of the teaching materials produced.

IV. CONCLUSION AND SUGGESTION

The results of using instructional materials in the context of Newton's gravity content have a substantial impact on scientific literacy. When instructional resources with the SSI context are used during the learning process, students' scientific literacy increases by 41% in the medium category. The study results show that students have a greater awareness of science-related social issues, including tidal floods.

Based on the research results, scientific research needs to be linked to social issues that exist in society so that it can increase students' awareness of existing social problems, such as drought issues related to the El Nino science phenomenon, flood issues related to the La Nina science phenomenon, or air pollution issues related to the science theme of steam (coal) power plants.

REFERENCES

Erssal, A. K. (2020). Pentingnya memperkirakan dan memperhitungkan terjadinya pasang surut air laut sebagai upaya dalam menunjang keselamatan pelayaran diwilayah tanjung emas oleh badan meteorologi, klimatologi, dan geofisika (bmkg) Semarang. *Karya Tulis*. Repository Universitas Martitim Amni Semarang

Espeja, A. G., & Couso, D. (2020). Introducing model-based instruction for ssi teaching in primary pre-service teacher education. *Science Teacher Education For Responsible Citizenship*, *52*, 153–171. https://doi.org/10.1007/978-3-030-40229-7_10

Foong, C. C., & Daniel, E. G. S. (2010). Assessing student's arguments in socio-scientific contexts: The considerations of structural complexity and the depth of content knowledge. *Procedia - Social and Behavioral Sciences*, *9*, 1120–1127. https://doi.org/10.1016/j.sbspro.2010.12.294

Fuadi, H., Robbia, A. Z., Jamaluddin, J., & Jufri, A. W. (2020). Analisis faktor penyebab rendahnya kemampuan literasi sains peserta didik. *Jurnal Ilmiah Profesi Pendidikan*, *5*(2), 108–116. https://doi.org/10.29303/jipp.v5i2.122

Genisa, M. U., Subali, B., Djukri., Agussalim, A., & Habibi, H. (2020). Socio-Scientific issues implementation as science learning material. *International Journal of Evaluation and Research in Education*, *9*(2), 311–317. http://doi.org/10.11591/ijere.v9i2.20530

Gulacar, O., Marwaha, R., & Goradia, K. R. (2022). Examining changes in students' perception of science relevancy and their career aspirations: Integrating sustainability-oriented socio-scientific issues into general chemistry curriculum. *Sustainable Chemistry and Pharmacy*, *25*, 100577. https://doi.org/10.1016/j.scp.2021.100577

Gurses, A., Gunes, K., Barin, T. B., Eroglu, Z., & Cozel, F. S. (2015). Relation between pre-service chemistry teachers' science literacy levels and their scientific process skills. *Procedia - Social And Behavioral Sciences*, *197*, 2395–2402. https://doi.org/10.1016/j.sbspro.2015.07.300

Handayani, Y. (2019). The effect of learning motivation and science learning outcomes of grade VIII students at SMP Unismuh Makassar. *Jurnal Pendidikan Fisika*, *7*(2), 245–252. https://doi.org/10.26618/jpf.v7i2.2083

Harefa, A. R. (2019). Peran ilmu fisika dalam kehidupan sehari-hari. *Majalah Ilmiah Warta Dharmawangsa*, *13*(2), 1–10. https://doi.org/10.46576/wdw.v0i60.411

Hasanudin, M., Kusmanto, E., & Budisetyawan, W. (2016). Amplifikasi pasang surut dan dampaknya terhadap perairan pesisir Probolinggo. *Oldi (Oseanologi dan Limnologi di Indonesia)*, *1*(3), 69–80.

Heydel, F., Engels, J. G., Feigs, J. T., Vásquez, E., Rudolph, B., Rohwer, J. G., & Jensen, K. (2017). Adaptation to tidal flooding and rapid genetic divergence between a narrow endemic grass species and its widespread congener lead to an early stage of ecological speciation. *Perspectives In Plant Ecology, Evolution And Systematics*, *27*, 57–67. https://doi.org/10.1016/j.ppees.2017.05.001

Hidayati, N. (2017). *Dinamika pantai*. Universitas Brawijaya Press.

Ilyas, I., Liu, A. N. A. M., & Doa, H. (2019). The effect of contextual teaching and learning (CTL) learning model on understanding the concept of waves of coastal school students. *Jurnal Pendidikan Fisika*, *7*(3), 317–324. https://doi.org/10.26618/jpf.v7i3.2225

Jho, H., Yoon, H.-G., & Kim, M. (2014). The relationship of science knowledge, attitude, and decision making on socio-scientific issues: the case study of students' debates on a nuclear power plant in Korea. *Science \& Education*, *23*, 1131–1151. https://doi.org/10.1007/s11191-013-9652-z

Ke, L., Sadler, T. D., Zangori, L., & Friedrichsen, P. J. (2021). We are developing and using multiple models to promote scientific literacy in the context of socio-scientific issues. *Science \& Education*, *30*, 589–607. https://doi.org/10.1007/s11191-021-00206-1

Kusjuriansah & Yulianto, A. (2019). Pengembangan bahan ajar fisika berbasis i-sets terkomplementasi karakter pada materi hukum gravitasi newton. *Upej Unnes Physics Education Journal*, *8*(2), 120–132. https://doi.org/10.15294/upej.v8i2.33314

Nasar, A., & Kaleka, M. B. U. (2019). Effectiveness of experimental laboratory methods on understanding the concept of light, science processes skills, and scientific attitudes of students. *Jurnal Pendidikan Fisika*, *7*(3), 262–270. https://doi.org/10.26618/jpf.v7i3.2333

Nazilah, N., Muharrami, L. K., Rosidi, I., & Wulandari, A. Y. R. (2019). Pengaruh bahan ajar berbasis socio-scientific issues pada materi pemanasan global untuk melatih kemampuan literasi sains siswa. *Natural Science Education Research*, *2*(1), 8–16. https://doi.org/10.21107/nser.v2i1.4162

Nugraha, A. L., Santosa, P. B., & Aditya, T. (2015). Dissemination of tidal flood risk map using online map in Semarang. *Procedia Environmental Sciences*, *23*, 64–71. https://Doi.Org/10.1016/J.Proenv.2015.01.010

OECD. (2019). *Pisa 2018 Assessment and analytical framework*. Oecd Publishing. https://doi.org/10.1787/5c07e4f1-en

Presley, M. L., Sickel, A. J., Muslu, N., Merle-Johnson, D., Witzig, S. B., Izci, K., & Sadler, T. D. (2013). A framework for socio-scientific issues-based education. *Science Educator*, *22*(1), 26–32.

Purwanto, M. N. (2019). *Prinsip-Prinsip dan teknik evaluasi pengajaran*. Remaja Rosdakarya

Rohmah, S. N., Iswari, R. S., & Saptono, S. (2022). The developing of biodiversity teaching materials based on socio-scientific issues to improve students' science literacy. *Journal Of Innovative Science Education*, *11*(2), 177–186. https://doi.org/10.15294/jise.v10i1.51531

Rostikawati, D. A., & Permanasari, A. (2016). Rekonstruksi bahan ajar dengan konteks socio-scientific issues pada materi zat aditif makanan untuk meningkatkan literasi sains siswa. *Jurnal Inovasi Pendidikan IPA*, *2*(2), 156–164. https://doi.org/10.21831/jipi.v2i2.8814

Rostikawati, D. A., & Saefullah, A. (2022). Analysis of the need for basic physics teaching materials in industrial engineering majors. *Gravity: Jurnal Ilmiah Penelitian dan Pembelajaran Fisika*, *8*(1), 34-40 http://dx.doi.org/10.30870/gravity.v8i1.14865

Rubini, B., Ardianto, D., Setyaningsih, S., & Sariningrum, A. (2019). Using socio-scientific issues in problem-based learning to enhance science literacy. *Journal of Physics: Conference Series*, *1233*, 1-4. Doi:10.1088/1742-6596/1233/1/012073

Sadler, T. D., Foulk, J. A., & Friedrichsen, P. J. (2017). Evolution of a model for socio-scientific issue teaching and learning. *International Journal of Education In Mathematics, Science and Technology*, *5*(2), 75–87.

Saefullah, A., Guntara, Y., & Rostikawati, D. A. (2021). Implementation of the use of textbooks with the context of socio scientific issues on climate change materials and its impact on life to improve students' scientific literacy. *Gravity: Jurnal Ilmiah Penelitian dan Pembelajaran Fisika*, *7*(2), 85-90.

http://dx.doi.org/10.30870/gravity.v7i2.12734

Saefullah, A., Samanhudi, U., Nulhakim, L., Berlian, L., Rakhmawan, A., Rohimah, B., & El Islami, R. A. Z. (2017). Efforts To Improve Students' Scientific Literacy Through Guided Inquiry Learning Based On The Local Wisdom Of Baduy's Society. *Jurnal Penelitian Dan Pembelajaran Ipa*, *3*(2), 84–91.

Sugiyono. (2013). *Metode penelitian pendidikan pendekatan kuantitatif, kualitatif dan R &D*. Alfabeta

Wahab, A., Junaedi, J., & Azhar, M. (2021). Efektivitas pembelajaran statistika pendidikan menggunakan uji peningkatan N-gain di PGMI. *Jurnal Basicedu*, *5*(2), 1039–1045. https://doi.org/10.31004/basicedu.v5i2.845

Yefremov, A. P., & Vorobyeva, A. A. (2021). A “space-ball” experiment to specify the nature of gravity in the solar system. *Acta Astronautica*, *186*, 438–444. https://doi.org/10.1016/j.actaastro.2021.06.005

Zahura, F. T., & Goodall, J. L. (2022). Predicting combined tidal and pluvial flood inundation using a machine learning surrogate model. *Journal of Hydrology: Regional Studies*, *41*, 1-18. https://doi.org/10.1016/j.ejrh.2022.101087

Zeidler, D. L., Herman, B. C., & Sadler, T. D. (2019). New directions in socio-scientific issues research. *Disciplinary and Interdisciplinary Science Education Research*, *1*(11), 1–9. https://doi.org/10.1186/s43031-019-0008-7