Basic Physics Concepts of New Renewable Energies

C Rochman 1,*, D Nasrudin1 and Sulasman2

1Physics Education Program, UIN Sunan Gunung Djati, Jl. A.H. Nasution 105 Bandung, Bandung, West Java, Indonesia
2The Study Program of Islamic History and Civilizations, UIN Sunan Gunung Djati Bandung, Jl. A.H. Nasution 105 Bandung, West Java, Indonesia

*chaerulrochman99@uinsgd.ac.id

Abstract. Supporting instructional materials play an important role in enhancing the literacy in physics concepts in secondary schools. The present study was aimed to describe supporting material-based physics literacy model. It employed a sequential mixed method using a quantitative literacy test and a qualitative provision of supporting materials about new renewable energies (NREs). The results showed that secondary school students demonstrated varied literacy in physics concepts and that physics teacher students demonstrated varied depth in their presentations of the supporting materials. In addition, there was a correlation between students’ physics literacy level and the ability of physics teacher students to deliver the supporting materials. This study concluded there was a correlation between secondary school students’ physics literacy and the provision of supporting materials about NREs. This implied the importance of the provision of supporting materials about NREs to enhance students’ physics literacy among secondary school students and physics teacher students.

1. Introduction

Supporting instructional materials play an important role in enhancing the literacy in physics concepts in secondary schools [1]. The supporting materials about NREs must be relevant to the curriculum and the energy literacy movement for all citizens of Indonesia[2]. The energy literacy movement for Indonesian citizens’ concerns with the management of NREs from solar-powered electric plants (PLTS), gas-powered electric plants (PLTG), hydroelectric power plants (PLT Air), nuclear powered electric plants (PLTN), etc.[3]. In some places, people are against the NREs because of their low literacy in NREs [4]. Supporting materials are necessary for strengthening students’ literacy in NREs.

In physics studies, it is important for students to understand the conceptual application of physics to various NREs. However, the understanding about NREs among physics teacher students could be said to low. In addition, there is no university course specifically designed to study NREs, neither does the secondary school curriculum give an emphasis on them despite the fact that the literacy of students and of teachers of science (esp. physics teachers) is absolutely necessary because the understanding of the utilization of NREs becomes a necessity to meet the energy needs of the present and future Indonesia. Thus, the present study was aimed to profile secondary school students’ literacy in NREs [5][6][7]. In addition, this study looked into the ability of physics teacher students in preparing and their awareness about the supporting materials. Several studies have indicated that it is necessary to enhance the awareness of scientific literacy among secondary school students and physics teacher students [7].
Based on the above explanation, this study was conducted using a survey method in 24 sites of NRE sources. The subjects were 26 physics teacher students and 26 groups of students in 26 secondary school students. The physics teacher students constructed the literacy testing instrument that consisted of four open ended questions. The data of literacy in NREs were measured using a 0-4 scoring scale. They addressed the test in 24 locations in which they did observations. The supporting materials were designed in accordance with the type of NRE they observed.

2. Methods
The research subjects were 26 third semester physics teacher students enrolled in the environmental physics class in 2016/2017 academic year at Universitas Islam Negeri Sunan Gunung Djati Bandung, Indonesia. They came from cities/regencies where the NREs were located. The data were collected in eight groups, divided based on eight types of NRE sources including hydroelectric power plants (PLT Air), steam-powered electric plants (PLTU), biogas-powered electric plants (PLT Biogas), gas-powered electric plants (PLTG), micro-hydroelectric power plants (PLTMH), wind-powered electric plants (PLT Angin), solar-powered electric plants, and biocell-powered electric plants (PLT Biosel). The physics teacher students prepared the supporting materials and disseminate NRE literacy instruments (concept, process, context, and behavior) in their respective places. The research instrument consisted of supporting instructional materials about NREs and four open-ended questions to test the literacy in NREs. The collected data included the supporting instructional materials and answers to the four open-ended questions about physics concepts, NRE processes, contexts, and attitudes of the secondary school students around the sites where the NREs were located. The physics teacher student-prepared supporting materials were analyzed using a rubric to describe physics concepts about NREs and the secondary students’ literacy in the types of NREs.

3. Results and discussion
The results of data analyses of physics concepts embodied in the supporting instructional materials about NREs, the ability to prepare the supporting materials, and the secondary school students’ literacy in NREs are presented in Figures 1, 2, and 3 below.

3.1. The distribution of physics concepts in NREs
The material distribution profile of the physics concepts contained in the physics teacher student-prepared supporting materials about the concept of NREs is illustrated in Figure 1.

![Figure 1. Profile of physics concept on NRE](image-url)

Figure 1 shows that the most involved physics concepts in NREs was magnetic electricity by 32.8%, and the smaller ones were modern physics concept by 3.4% and others by 3.8%. The concept of magnetic electricity was a cluster of a major part of a power plant, regardless of the energy source.
It is at this point that magnetic electricity became the most important concept. That was why there were more contents about magnetic electricity concepts in the supporting instructional materials than any other concepts.

3.2. Profile of literacy in NREs and the ability to prepare NRE supporting materials
The average scores of literacies in NREs and ability to prepare NRE supporting materials is illustrated in Figure 2.

![Figure 2. The average score of literacy competencies and supporting materials of the new and renewable energy](image)

Figure 2 shows that the highest average score of secondary school students’ NRE literacy was of biogas by 2.29, and the lowest one was of biocell by 1.45. However, the highest average score of physics teacher students’ ability to prepare the supporting materials was of solar power by 3.2, and the lowest ones were of hydroelectric power plant, biogas, and biocell by 2.4.

Seeing the average scores in Figure 2, the NRE literacy of secondary school students could be said to be low. In a 0-4 scale, the overall average score of NRE literacy was 1.89. This confirms findings of some previous studies that the awareness of people (including secondary school students) around the NRE installation sites were low. Other factors contributing to their low awareness and the problems associated with it include storage, capacity, areal width, supporting energy source, economy [8], and public support[9].

Low public support for some NREs; among others, is due to the methane gas (CH4) and carbon dioxide (CO2) emissions caused by some NRE installations like waste-powered electricity plants [10]. The same applies to nuclear energy in that the society perceive nuclear to be risky and very dangerous[11] despite the fact that it is a very potential and highest capacity energy source since it does not require large land and a lot of fuel consumption [2].

The enormous potential of energy is in vain because there is no public awareness to involve themselves in the utilization of NRE sources. To date, people are still illiterate in the benefits of NREs and other energies available in their surroundings [11][12]. In order to be literate in energy, they need to get sufficiently informed through an energy literacy education program[5] [7][13][14].

3.3. Comparison between NRE literacy and the ability to prepare NRE supporting materials
The average scores of NRE literacy and ability to prepare NRE supporting materials is illustrated in Figure 3.
Figure 3. Profile of physics literacy competencies and supporting materials

Figure 3 shows the comparison between secondary school students’ literacy in NRE and the ability of physics teacher students to prepare NRE supporting materials. Using the same scoring scale, it was revealed that the average scores of the ability of physics teacher students to prepare supporting instructional materials about NREs was higher than that of secondary school students’ literacy in NREs. In a 0-4 scale, the first was 2.65, and the latter was 1.89.

It goes to show that it takes reading materials to get adequately informed about NREs. Physics teacher students can access Internet to get informed, but this was not the case with the secondary school students. They need supporting physics instructional materials to get informed. Therefore, physics teachers should be equipped with the ability to prepare supporting physics instructional materials relevant to the NREs available locally.

Based on the above calculations, it was revealed that there was a correlation between secondary school students’ literacy in NREs and the ability of physics teacher students to prepare supporting NRE instructional materials. And the correlation value was 0.42, or could be said to be moderate. This indicates that the presentation of supporting materials could enhance secondary school students’ literacy in NREs as much as 42%. However, this correlational calculation should be reviewed and developed into a literacy model of physics concept of local NREs.

4. Conclusion

The concept of magnetic electricity is the most extensively discussed in the supporting NRE instructional materials. The NRE literacy of secondary school students is closely related to the ability of physics teachers to prepare the supporting NRE instructional materials. Although the NRE literacy in West Java was varied, the ability of physics teachers to prepare the supporting NRE instructional materials could be said to below the average. This means that the secondary school students were not sufficiently informed about the potential of local NREs.

It is recommended that a physics literacy-based supporting instructional material model be developed in accordance with the locally available NREs.
References

[1] M. K. Arief and S. Utari 2015 Implementation of Levels of Inquiry on Science Learning To Improve Junior High School Student’s Scientific Literacy Penerapan Levels of Inquiry Pada Pembelajaran Ipa J. Pendidik. Fis. Indones. 11 2 117–125

[2] PDTI ESDM 2015 Perkembangan Penyediaan dan Pemanfaatan Migas Batubara Energi Baru Terbarukan dan Listrik Jakarta: Kementerian ESDM

[3] A. D. Aiman A. Alawin, Taieseer Abu Rahmej, Jamal O. Jaber, Suliman Loubani, Sameh Abu Dalu and Wael Awad 2016 Renewable energy education in engineering schools in Jordan: Existing courses and level of awareness of senior students Renew. Sustain. Energy Rev. 55 1154–1162

[4] M. A. Kurnaz and A. Sağlam-arslan 2011 A Thematic Review of Some Studies Investigating Students’ Alternative Conceptions About Energy Eurasian J. Phys. Chem. Educ. 3 1 51–74

[5] A. Hobson 2003 Physics literacy, energy and the environment Phys. Educ. 38 2 109–114

[6] F. Fakhrirah, S. Masfuah, M. Royza, A. Rusilowati and E. Rahayu 2017 Student ’ s Science Literacy in The Aspect of Content Science J. Pendidik. IPA Indones. 6 1 81–87

[7] A. Rusli 2016 Science Awareness and Science Literacy through the Basic Physics Course: Physics with a bit of Metaphysics J. Phys. Conf. Ser. 739 12012

[8] I. Santosa, M. P. Azirifarwan, S. Tp, M. Eng 2012 Studi Tekno Ekonomi Pembuatan Biogas di PT. SHGW (Stichting Het Groene Woud) Bio Tea Indonesia J. Energi Altern.

[9] L. S. U. Peranginangin 2014 Partisipasi Masyarakat dalam Pengelolaan Kawasan Konservasi Lilly Sri Ulina Peranginangin Penganalisa Bahan dan Pemanfaatan pada Balai KSDA Sumatera Barat J. Kebijakan Adm. Publik

[10] O Suagwu, C Hiemerio, G Odday, O Suagwu, U Chechukuwi L Evi and A Gamuthu and P Ariatamby 2014 Bio-Hydrogen Production from Food Waste through Anaerobic Fermentation (Pengeluaran Bio Hidrogen daripada Sisa Makanan melalui Fermentasi Anaerobik),” Sains Malaysia 43 12 1927–1936

[11] C. L. Eheazu 2014 Acquisition of Environmental Literacy by Nigerian University Students : An Empirical Study J. Educ. Pract. 5 11 20–27

[12] A. Allman and P. Daoutidis 2016 Optimal design of synergistic distributed renewable fuel and power systems Renew. Energy 100 78–89

[13] C. Rochman 2010 Pengembangan Program Pembelajaran Mahasiswa Calon Guru Fisika Dalam Menyusun Program Pembelajaran UPI Bandung

[14] C. Rochman 2015 Penerapan Pembelajaran Berbasis Scientific Approach Model 5M and Analisis Kemampuan Literasi Sains Peserta Didik pada Sekolah Mitra Universitas Islam Negeri Sunan Gunung Djati Bandung in Seminar Kontribusi Fisika 435–440

[15] K. I. K. Setiawati and A. Rusilowati 2013 Pembuatan Buku Cerita IPA yang Mengintegrasikan Materi Kebencanaan Alam untuk Meningkatkan Literasi Membaca dan Pembentukan Karakter J. Pendidik. IPA Indones. 2 2 129–135

[16] Z. Fang and Y. Wei 2010 Improving Middle School Students’ Science Literacy Through Reading Infusion J. Educ. Res. 103 4 262–273

[17] G. Franklin 2007 Wiki anyone? Reflections on an information literacy class wikij. Inf. Lit.v1 3 1–12

[18] Parmin, Sajid, Ashadi and Sutikno 2015 Skill of Prospective Teacher in Integrating The Concept of Science With Local Wisdom Model J. Pendidik. IPA Indones. 4 2 120–126

[19] B. Setiawan, D. K. Innatesari and W. B. Sabtiawan 2017 The Development of Local Wisdom-based Natural Science Module to Improve Science Literation of Students J. Pendidik. IPA Indones. 6 1 49–54

[20] G. Sontay 2015 A Comparative Investigation of Sub-Components of the Environmental Literacy at the Secondary School Level J. Turkish Sci. Educ. 12 1 19–28

[21] H. Akengin and A. Sirin 2013 A comparative study upon determination of scientific literacy level of teacher candidates Educ. Res. Rev. 8 19 1882–1886
[22] B. Anilan 2014 A Study of the Environmental Risk Perceptions and Environmental Awareness Levels of High School Students Asia-Pacific Forum Sci. Learn. Teach. 15 2 1–23
[23] S Durojaiye, F Akinyemi, S Abiodun and O Taiwo 2014 A Discourse on the Essentials of Transformative Science Teacher Professionalism and Scientific Literacy in the Challenges of Global Economic Crisis J. Educ. Pract. 5 8 26–31