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Research Article

Designing Geoscience Learning for Sustainable Development: A Professional Competency Assessment for Postgraduate Students in Science Education Program

Eko Hariyono [1,a], Abadi [2,b], Liliasari [3,c], Agus Fani Candra Wijaya [4,d], and Hiroki Fujii [5,e]

[1] Department of Physics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya
Jalan Ketintang, Surabaya 60231, Indonesia

[2] Department of Mathematics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya
Jalan Ketintang, Surabaya 60231, Indonesia

[3] Science Education Program, Postgraduate School, Universitas Pendidikan Indonesia
Jalan Setiabudhi No 229, Bandung 40154, Indonesia

[4] Department of Physics, Education Faculty of Mathematics and Natural Sciences,
Universitas Pendidikan Indonesia
Jalan Setiabudhi No 229, Bandung 40154, Indonesia

[5] Okayama University of Education for Sustainable Development Promotion Center.
3-1-1 Tsushimanaka, Kita-ku, Okayama, 700-8530, Japan

e-mail: [a] ekohariyono@unesa.ac.id, [b] abadi@unesa.ac.id, [c] liliasari@upi.edu, [d] agus.fany@gmail.com, and [e] fuji-hi@okayama-u.ac.jp

Abstract

This research involved 19 postgraduate students majoring on Science Education at one university in Surabaya who were programming Earth and Space Sciences course. The objective of this research is to measure students' ability in designing a lesson plan for sustainable education on environmental issues around volcanoes by integrating education for sustainable development (ESD) competence. Descriptive quantitative analysis was employed to assess the lesson plans developed by the students. In general, the results showed that the lesson plans were less contextual to support the improvement of decision-making abilities on the environmental issues, the emergence of environmental awareness among students, encouragement to the students to have sense of belonging to the environment, and fostering critical analysis of various environmental phenomena. The results suggest further efforts to improve professional competence of the postgraduate students in developing geoscience learning instruments, particularly related to integrate the ESD competence into lesson plans.

Keywords: *geoscience learning, sustainable development, professional competencies*

Merancang Pembelajaran Geosains untuk Pembangunan Berkelanjutan: Sebuah Penilaian Kompetensi Profesional bagi Mahasiswa Pascasarjana Program Pendidikan IPA

Abstrak

Penelitian ini melibatkan 19 mahasiswa program pendidikan sains pascasarjana di salah satu universitas di Surabaya yang mengambil mata kuliah Ilmu Pengetahuan Bumi dan Antariksa. Tujuan dari penelitian ini adalah mengukur kemampuan siswa dalam merancang rencana pembelajaran untuk pendidikan berkelanjutan berdasarkan isu lingkungan di sekitar gunung api dengan mengintegrasikan kompetensi ESD. Metode yang digunakan adalah analisis deskriptif kuantitatif berdasarkan hasil penilaian terhadap rencana pembelajaran yang telah dikembangkan oleh mahasiswa. Hasil penelitian menunjukkan bahwa rencana pembelajaran kurang terkait untuk mendukung peningkatan kemampuan pengambilan keputusan pada isu lingkungan, munculnya kesadaran lingkungan di kalangan siswa, mendorong siswa untuk memiliki rasa memiliki terhadap lingkungan, dan memupuk analisis kritis terhadap berbagai fenomena lingkungan. Berdasarkan hasil penelitian dapat disimpulkan bahwa kompetensi profesional mahasiswa pascasarjana dalam mengembangkan instrumen pembelajaran geosains perlu ditingkatkan. Siswa belum mampu mengintegrasikan kompetensi ESD ke dalam rencana pelajaran.

Kata Kunci: *pembelajaran geosains, ESD, kompetensi profesional*

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I. INTRODUCTION

Sustainable development is now becoming an important issue in preparing the global community to face the emerging challenges on environmental changes globally. This concept has emerged as a response to environmental problems due to the impacts of social life [1]. Sustainable education is believed to ensure all people obtaining knowledge, values, and skills for better life and society in a sustainable way [2,3] and help students to minimize the gap between local and global issues [4].

The great idea of Education for Sustainable Development (ESD) is to equip students with interdisciplinary sustainable competences through student-centered and pluralistic-democratic learning strategies [5]. This idea is highly relevant to the concept of geoscience education that is expected to realize the sustainability on Earth [4], which aims to ensure that all inhabitants of the planet Earth have knowledge of the natural processes that shape the physical environment and understand how human activities' impacts on the Earth on the local, regional and global scales [6]. In addition, it focuses on improving the

understanding of the emerging challenges to the communities related to natural disasters, natural resources, economics, and ecological systems [3,7].

The ESD program is a new innovation and very potential to be implemented and developed in Indonesia. ESD is more focused on developing the attitudes and skills of the communities to deal with regional and global issues related to environmental aspect through education [8] and able to make ease life as well as finding relevant solutions upon the issues [1]. Although it has been introduced by UNESCO since 2005, this program is less concerned seriously in related with the development of science education programs in higher education [9]. Given the high risks of natural disasters in Indonesia due to its geological and geographical location, the ESD program is considered very important to be implemented with the aim of being able to build community resilience in the face of the changing geographic phenomena.

The environmental issues and sustainable development program are inseparable conncetion [10-12]; for this reason [13], education should emphasize and related the learning process with the Earth context which is part of the process of developing human resources and strengthening the environmental education. From this, it is expected to create knowledgeable communities who are able to manage the environment in various approaches responsibly.

One indicator of the success in integrating ESD competence of in this context is the ability of the postgraduate students to design a lesson plan as one of the fundamental components for professional teachers. The lesson plan is a key factor in education process [14] and may help to ensure the unidirectional learning with the objectives of the curriculum and illustrates the success of learning in the assessment units [15].

Currently, the number of lesson plans which integrate ESD competence, in particular related to the environmental issues, is only quite few [16]. Therefore, this research focuses on the ability of the postgraduate students to develop lesson plans which integrate the ESD competences, namely acting and making decisions, increasing environmental awareness, thinking about the various alternatives to the emerging problems, fostering sense of belonging to the environment, and having a critical analysis of natural phenomena from different perspectives [16]. From this study, it is expected that the students are able to (i) build appropriate explanations based on experience, discuss and explain the concepts based on their understanding, and (ii) apply the knowledge acquired and skills developed to solve real problems by requiring information integration from several disciplines, both related with science and other major (interdisciplinary context) [17].

The purpose of this research is to measure the ability of postgraduate students in creating lesson plans by integrating ESD competences based on the environmental issues. The rationale for the measurement is the importance of an effort to develop students' skills in designing contextual learning in science education.

II. RESEARCH METHOD

This is a quantitative descriptive study with the focus on the critical study of the ability of postgraduate students (n=19) in developing a lesson plan based on environmental issues around volcanoes by integrating the ESD competences. The postgraduate students involved were attending Earth and Space Sciences course of 2017/2018, majoring on Science Education Program. The profile of the participants is presented in Table 1.

Table 1. Students' frequency distribution based on class and gender

Variables	Classes	Number of participants	Male	Female
Postgraduate students	IPBA 2017 A	9	1	8
majoring on Science	IPBA 2017 B	4	0	4
Education Program	IPBA 2017 C	6	1	5

Table 2. Students' responses toward lesson plans based on ESD

Statements	Attitude scale (%)				
	SDA	DA	U	A	SA
ESD is a new material in Earth and Space Science learning	0	0	0	10.53	89.47
ESD is a very interesting material	0	0	10.52	21.05	63.16
ESD competences can be integrated into Earth and Space Science learning	0	5.26	15.79	36.84	42.11
ESD is very important for students	0	0	0	21.05	78.95

SDA: Strongly Disagree; DA: Disagree; U: Undecided; A: Agree; SA: Strongly Agree

Data were obtained from the results of questionnaires distributed to the participants in the form of students' responses toward the lesson plans being developed based on the ESD consisting of the environmental issues that have been offered and also critical assessments of the lesson plans.

III. RESULTS AND DISCUSSION

The concept of good education is in accordance with the needs of the community and clear with limited impact [18] and helping to create professional individuals [19]. The success of sustainable education is indicated by the changes in people's behaviors in strengthening environmental resilience and instilling awareness of climate change within the community [20]. ESD can be categorized as innovation in science education program. It is believed to create new approaches in science learning as characterized by new directions and cultures in education both in content and learning methods [2].

The ability to integrate ESD competences, for instance in geosciences learning, is important for the students majoring on science education and studying at graduate level. This position is related to the efforts to formulate an ideal learning design in accordance with the needs of schools and community to prepare the education institutions in providing optimal services for learners with education program that puts concern with the emerging global issues.

To this paradigm, universities should be able to accommodate such topics related to sustainable environmental changes and directed to new strategies, so that the universities are more likely prepared to facing changes in the future [21,22]. The main objective of this demand is to equip the students to understand how to interact with society as well as the environment in order to minimize the risks and potential impacts of human activities [23].

One reason why students majoring on science education are required to learn about education for sustainable development (ESD) is this program is to combine several aspects, namely environmental issues with social changes and economic growth [5]. It is believed to become fundamental strategy to prepare the students to give more contributions in supporting the sustainability of society to the environmental changes.

In addition, ESD is believed to encourage the students be more active in learning participations, especially in terms of asking questions, analysing issues, critical thinking and making decisions [24]. To find out the students' responses toward the lesson plans developed by the postgraduate students based on ESD is presented in Table 2.

Based on the students' responses, it is obvious that the ESD materials are essential for students majoring on Science Education, in particular in Geoscience topic. Even though it is still considered as a new content in Earth and Space Science course, the topic receives more concerns among postgraduate students.

However, in understanding the roles of ESD content, the students are not yet fully convinced of the integration of ESD competences in science learning. There are some students (5.26%) who did not agree if the sustainable development competencies can be integrated into the Earth and Space Science materials.

In relation with the ability of the postgraduate students to develop the lesson plan, statistical analysis was conducted to determine whether or not there were differences in the abilities of each class. Considering the small number of participants, the class was conditioned into two groups; Group 1 was IPBA17 A with the number of participants of 9 students and Group 2 was IPBA17 B+C with the number of participants of 10 students.

In Table 3, it is known that there is a significant difference in terms of the average scores between Group 1 and Group 2. It means that in average, the ability of the students in Group 1 was better than Group 2 in in developing the lesson plan. Based on the Levine's test for equality of variances, it is known that there were differences in the ability of the students to prepare the lesson plan for each group. This can be seen from the output significance value (2 tailed) of 0.011<0.050 (Table 4), meaning that there was an average difference between the two groups in developing the lesson plan.

Table 3. Mean and standard deviation values about the ability of preparing a lesson plan

	Group	N	Mean	SD
LP	Group 1	9	85.0000	5.02494
	Group 2	10	79.4000	3.53396

Table 4. T-test to determine the relationship of ability to arrange a lesson plan in each group

		F	Sig.	T	df	Sig. (2-tailed)
LP	Equal variances assumed	1.155	.298	2.834	17	.011
	Equal variances not assumed			2.781	14.205	.015

The lesson plan developed by each student was designed based on the environmental issues, e.g. matural destruction around the volcanoes. The topic is considered highly relevant to ESD programs that address the environmental concerns. There are four aspects to assess the lesson plan, namely: (1) relevance of lesson plans with the environmental issues, (2) the accuracy of selecting the learning strategies, (3) the suitability of the teaching media used, and (4) conformity of materials with education levels.

Based on the results of a critical review of the lesson plans that have been developed by the postgraduate students majoring on Science Education Program, the ability of the students in developing lesson plan is good, particularly in relation to the suitability of lesson plans with the environmental issues and the learning materials with education level. However, the accuracy of selecting suitable learning strategies is likely low. The students are believed to need supervision in terms of selecting suitable learning strategies that may accommodate the five ESD competences. As an illustration of the lesson plans is presented in Figure 1.

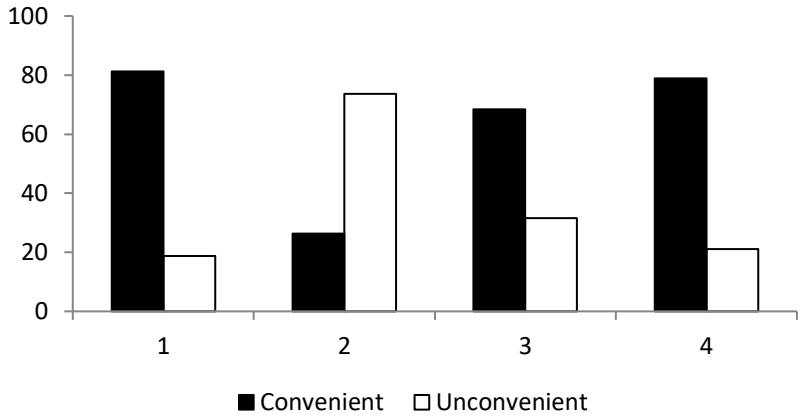

Figure 1. The lesson plans profile was developed by students

Most teachers acknowledge that the lesson plans may determine the quality of education [14] and become one of basic indicators for being a professional teacher [25]. This means that the ability to develop a lesson plan is very fundamental for prospective science teachers as well [26]. Lesson plans are employed to organize knowledge content to be conveyed to students in learning process [27].

Based on the process of the development of the lesson plans, there were some students who did not understand the characteristics of appropriate learning strategy in accommodating problem-solving skills of the students in the area of geoscience. Students have been fastened by rigid learning models, prioritizing the assessment of scientific process skills that are theoretical, and have not focused on the ability to solve problems. Some lesson plans still employed Jigsaw type cooperative models and beach ball type discussions which are considered less relevant to the objectives of geoscience learning.

Table 5. Integration of ESD competences in a lesson plan based on the environmental issues

No	ESD competences	Percentage (%)
1	Acting and making decisions	10.52
2	Increasing environmental awareness	15.78
3	Thinking about various alternatives to problems	10.52
4	Growing a sense of belonging to the environment	10.52
5	Having a critical analysis of the phenomenon from different perspectives	5.26

Based on the assessment of the lesson plans developed (see Table 5), it can be shown that the ability of students to integrate the ESD competences is relatively low. The level of the new lesson plans come to the limit of raising environmental awareness, while other ESD competences such as acting and making decisions, thinking about alternatives to solve problems and growing sense of belonging to the environment cannot yet be fully integrated into the learning process as indicated from the lesson plans.

The ability of the students to integrate ESD competences in science learning is not a simple task. In the context of teaching practices, teachers are required to have such competences to create a conducive learning atmosphere, selecting proper and suitable learning approaches that suit the individual's background and students' abilities (levels); the right selection and utilize of the methods could become the opportunities to actively engage students in learning process [18], which in turn will improve students' competence. To achieve this setting, the graduate students should really understand which important competences and be able to utilize in learning activities. This is a bit contrary to the results of previous research which stated that there is no significant relationship between ESD competences of the students and the actual awareness and perspectives of students related to sustainable development program [16]. To optimize this ability, developing ESD content knowledge is needed as it is an essential element in teaching practices [28], and it should become education priority which is in accordance with the emerging sustainable professional development [26].

The results of this study are very important to expose and represent the ability of postgraduate students majoring on Science Education to develop lesson plans in geoscience learning. The ability to integrate environmental issues in learning activities is expected to be able to help the community to solve problems related to environmental changes. At the end, geoscience learning which is ineffective as it does not fit the needs of the community [29] can be minimized.

IV. CONCLUSION

There are some interesting findings related to the ability of the postgraduate students in developing lesson plans by integrating ESD competences, namely: (i) ESD is an essential material for postgraduate students majoring on Science Education Program, (ii) the ability of students to develop lesson plans ESD based is good, but still weak in selecting appropriate learning strategies for problem-solving skills, (iii) students who are not able to integrate ESD competences are expected to give more attention on the preparation of lesson plans which accommodates environmental issues. Despite the fact that the results of this study are likely not optimal, the integration of sustainable development in education is very potential in building public awareness on the emerging environmental changes both locally and globally.

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REFERENCES

[1] Bakhati P. Promoting Education for Sustainable Development: Role of Teacher. *Journal of Training and Development*. 2015; **1**(1): 21-26. Available from: https://www.nepjol.info/index.php/JTD/article/download/13086/10550.

[2] Dannenberg S and Grapentin T. Education for Sustainable Development - Learning for Transformation. The Example of Germany.

Journal of Futures Studies. 2016; **20**(3): 7–20. DOI: https://dx.doi.org/0.6531/JFS.2016.20(3).A7.

[3] Klarin T. The Concept of Sustainable Development: From its Beginning to the Contemporary Issues**.** *Zagreb International Review of Economics & Business*. 2018; 21(1): 67-94. DOI: https://dx.doi.org/10.2478/zireb-2018-0005.

[4] Gosselin D C, Manduca C, Bralower T J, and Mogk D. Transforming the Teaching of Geoscience and Sustainability. *Eos, Transactions, American Geophysical Union*. 2013; **94**(25): 221-222. DOI: https://doi.org/10.1002/2013EO250002.

[5] Pauw JB, Gericke N, Olsson D, and Berglund T. The Effectiveness of Education for Sustainability Development. *Sustainability*. 2015; **7**(11): 15693-15717. DOI: https://doi.org/10.3390/su71115693.

[6] Locke S, Libarkin J, and Chang CY. Geoscience Education and Global Devlopment. *Journal of Geoscience Education*. 2012; **60**: 199-200. Available from: https://files.eric.ed.gov/fulltext/EJ1164210.pdf.

[7] LaDue ND and Manning CB. Next Generation Science Standards: A Call to Action for the Geoscience Community. *GSA Today.* 2015; **25**(2): 28-29. Available from: http://www.geosociety.org/gsatoday/archive/25/2/article/i1052-5173-25-2-28.htm.

[8] Tanaka H. *Education for Sustainability Development Education in Japan*. Tokyo: ESDRC Rikkyo University; 2009.

[9] Filho WL, Raath S, Lazzarini B, Vargas VR, de Souza L, Anholon R, Quelhas OLG, Haddad R, Klavins M, and Orlovic VL. The Role of Transformation in Learning and Education for Sustainability. *Journal of Cleaner Production*. 2018; **199**: 286-295. DOI: https://doi.org/10.1016/j.jclepro.2018.07.017.

[10] Awan AG. Relationship between Environment and Sustainable Economic Devopment: A Theoretical Approach to Environmental Problems. *International Journal of Asian Social Science*. 2013; **3**(3): 741-761. Available from: http://aessweb.com/pdf-files/741-761.pdf.

[11] Mora G. The Need for Geologist in Sustainable Development. *GSA Today*. 2013; **23**(12): 36-37. Available from: http://www.geosociety.org/gsatoday/archive/23/12/article/i1052-5173-23-12-36.htm.

[12] Kopnima H. Contesting 'Environment' Through the Lens of Sustainability: Examining Implications for Environmental Education (EE) and Education for Sustainable Development (ESD). *Culture Unbond-Journal of Cultural Research*. 2014; **6**: 931-947. Available from: http://www.cultureunbound.ep.liu.se/v6/a51/cu14v6a51.pdf .

[13] Kraft KJ, Srogi L, Husman J, Semken S, and Fuhrman M. Engaging Students to Learn Through the Affective Domain: A new Framework for Teaching in the Geoscience. *Journal of Geoscience Education*. 2011; **59**(2): 71-84. DOI: https://dx.doi.org/10.5408/1.3543934a.

[14] Nesari AJ and Heidari M. The Important Role of Lesson Plan on Educational Achievement of Iranian EFL Teachers' Attitudes. *International Journal of Foreign Language Teaching & Research*. 2014; **2**(5): 25-31. Available from: http://jfl.iaun.ac.ir/article_10884.html.

[15] Duncan G and Met M. *STARTALK: From Paper to Practice*. College Park, MD: National Foreign Language Center at the University of Maryland; 2010. Available from: http://carla.umn.edu/technology/STARTALK/images/LessonPlanningGuide.pdf.

[16] Cebrian G and Junyent M. Competencies in Education for Sustainable Development: Exploring the Student's Teacher View.

Sustainability. 2015; **7**(3): 2763-2786. DOI: https://dx.doi.org/10.3390/su7032768.

[17] Brunkhorst and Bonny J. A Working Model for Evaluating Academic Excellence in Geoscience Education, Undergraduate, and K-12. *Journal of Geoscience Education*. 2002; **50**(1): 72-77. Available from: https://eric.ed.gov/?id=EJ646101.

[18] Rauch F and Steiner R. Competences for Education for Sustainable Development in Teacher Education. *CEPS Journal*. 2013; **3**(1): 9-24. Available from: https://www.pedocs.de/volltexte/2013/7663/pdf/cepsj_20013_1_Rauch_Steiner_Competences_for_education_for_sustainable_development.pdf.

[19] Dovros N and Makrakis V. Transforming the Classroomi into a Reflective Community: A Blended Learning Instructional Approach. *Journal of Teacher Education for Sustainability*. 2012; **14**(2): 73-88. DOI: https://doi.org/10.2478/v10099-012-0010-z.

[20] Bangay C. Protecting the Future: The role of School Education in Sustainable Development – an Indian Case Study. *International Journal of Development Education and Global Learning*. 2016; **8**(1): 5-19. Available from: https:///files.eric.ed.gov/fulltetext/EJ1167824.pdf.

[21] Peter CJ, Libunao WH, and Latif AA. Extent of Education for Sustainable Development (ESD) Integration in Malaysia Community Colleges. *Journal of Technical Education and Training (JTET)*. 2016; **8**(1): 1-13. Available from: http://penerbit.uthm.edu.my/ojs/index.php/JTET/article/view/1194.

[22] Perello-Marin MR, Ribes-Giner G, and Diaz OP. Enhancing Education for Sustainable Development in Environmental University Programmes: A Co-Creation Approach. *Sustainability*. 2018; **10**(1): 158. DOI: https://dx.doi.org/10.3390/su10010158.

[23] Gunamantha IM. Pendidikan untuk Pembangunan Berkelanjutan: Mengapa, Apa dan Bagaimana. *Jurnal Pendidikan dan Pengajaran*. 2010; **43**(3): 215-221. DOI: http://dx.doi.org/10.23887/jppundiksha.v43i3.125.

[24] Laurie R, Tarumi YN, McKeown R, and Hopkins C. Contributions of Education for Sustainable Development (ESD) to Quality Education: A Synthesis of Research. *Journal of Education for Sustainable Development.* 2016; **10**(2): 226-242. DOI: https://doi.org/10.1177/0973408216661442.

[25] Jones J. Lesson Planning: Towards Purposful Learning and Effective Teaching. *Encuentro. Revista de Investigación e Innovación en la clase de idiomas.* 1998; **10**: 89-98. Available from: https://pdfs.semanticscholar.org/4a32/af0ccabdf25708e56094b69a934f15f30e59.pdf.

[26] Ling HP. Science Teaching Experiences in Informal Settings: One Way to Enrich the Preparation Program for Preservice Science Teachers. *Universal Journal of Educational Research*. 2016; **4**(5): 1214-1222. DOI: https://dx.doi.org/10.13189/ujer.2016.040535.

[27] Cummings ML, Goodrich M, and Burmester D. Geoscience for Elementary Educators: A Course Assessment. *The Journal of Mathematics and Science: Collaborative Explorations*. 2003; **6**: 127-140. Available from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.514.9516&rep=rep1&type=pdf.

[28] Hudson P. Understanding Preservice Teachers' Development of Pedagogical Knowledge Practices When Co-Teaching Primary Science to Peers. *Journal of Science and Mathematics in Southeast Asia*. 2014; **37**(1): 44-66. Available from: https://eprints.qut.edu.au/80086/1/.

[29] Hariyono E, Liliasari, Tjasyono B, and Madlazim. Volcanic Eruption Crisis and the Challenges of Geoscience Education in Indonesia. *AIP Conference Proceedings*. 2016; **1708**: 080004. DOI: https://doi.org/10.1063/1.4941190.