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Development of an Educational Program and Rubric for Environmental Education in Pre-service Teacher Training: A Case Study in Japan

TOMOKAWA Sachi
Institute of Education, Shinshu University
WATANABE Ryuichi
Faculty of Education, Shinshu University
SHIMADA Hideaki
Institute of Education, Shinshu University
MURAMATSU Hiroyuki
Institute of Education, Shinshu University
NISHI Masaaki
Art Science Department, Osaka University of Arts
MIYAKE Kimihiro
Faculty of Education, Shinshu University

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1. Introduction

Over the past four decades, environmental concerns have come to be regarded as universal issues. To enhance environmental awareness throughout the world, international society has advocated teaching environmental education (EE) in schools. Implementing EE in pre-service teacher training is one of the essential educational approaches (United Nations Educational, Scientific and Cultural Organization & United Nations Environment Programme, 1990). After the adoption of the Belgrade Charter (United Nations Educational, Scientific and Cultural Organization, 1975), international organizations clearly declared the purpose and importance of EE in reports and declarations such as the final report on the intergovernmental conference on EE in 1977 (United Nations Educational, Scientific and Cultural Organization, 1977), the Rio Declaration in 1992 (United Nations, 1992), and the Thessaloniki Declaration in 1997 (United Nations Educational, Scientific and Cultural Organization, 1997). In particular, the final report of the intergovernmental conference on EE in 1977 concluded that EE should be included in pre-service teacher training

curricula, and the report emphasized improvement of EE in-service teacher training (United Nations Educational, Scientific and Cultural Organization, 1977).

However, previous studies reported several barriers to teaching EE in school. Ham (1988) reported that lack of time for teaching and preparation was the most important barrier in EE teaching in elementary school although teachers had positive attitudes to EE teaching. Lack of instructional materials and funding was also reported as important hurdles (Ham,1988). Moreover, insufficient scientific knowledge was found to be a significant barrier especially in teachers from non-scientific backgrounds. Ham (1988) concluded that integration of EE into various subjects is important for overcoming these barriers. In addition, a multidisciplinary view of EE is needed to help pre-service teachers promote integration of EE into other subjects (Ham, 1988). Another study reported the necessity to narrow the gap between required content in school and learning content in teacher training institutions to improve the quality of EE teaching in schools (Marcus & John, 2000).

A literature review of EE in pre-service teacher training reported low levels of environmental competence, knowledge of environmental issues and readiness to teach EE among students (Álvarez-García et al., 2015). Low environmental literacy in pre-service teachers was reported in several countries including Australia (Miles et al., 2006) and Israel (Pe'er et al., 2007). Other studies reported a lack of environmental concerns in Lebanon (Vlaardingerbroek, 2007) and Turkey (Tuncer, 2009), and low awareness of impact of their daily activities on the environment among pre-service teachers in Spain (Ull, 2014).

According to Álvarez-García et al. (2015), most pre-service teachers have positive attitudes towards EE in their role as students, although their attitudes are more negative when assumed to be in their future role as teachers. Students believed that EE would help them to become acquainted with more innovative teaching methods and to improve teacher-student relationships (Álvarez-García et al., 2015). Studies reported gaps between teacher training curricula on EE and required competencies for teaching EE in schools (Álvarez-García et al., 2015; Mastrilli, 2005). Moreover, Álvarez-García et al.'s (2015) review highlighted the need for EE training for pre-service teachers, and concluded that the major responsibility of the teacher training institution is to promote interest in environmental issues among their students to enable them to not only look for solutions to environmental problems, but also to be professional promoters of sustainability. Dada (2017) reported the effectiveness of providing education on EE in improving knowledge, attitude, and perception of environmental issues among pre-service teachers. However, the effect of EE programs

on awareness and confidence of pre-service teachers has not been examined sufficiently in many of the studies to date. A rubric is a simple assessment tool that describes levels of performance on a particular task and is used to assess outcomes in a variety of performance-based contexts (C. Hafner & M. Hafner, 2003). To date, there have been no studies that use rubrics with pre-service teachers as a tool to evaluate EE outcomes in a systematic way.

In Japanese school education, there is no formal subject called 'Environmental Education.' EE is taught by cross curricular teaching in several subjects such as science, social studies, home economics, health education, Japanese language and moral education (Kodama, 2017). Several specific classes are conducted with an environmental viewpoint in the entire education of each school, and this environmental viewpoint is incorporated into each subject and extracurricular activity such as the period for integrated study, special activities, and moral education (Kodama, 2017). Since 1991, the Ministry of Education, Culture, Sports, Science and Technology in Japan (MEXT) has published and revised relevant guidelines to incorporate EE into different subjects and facilitate teaching of EE in elementary school (National Institute for Educational Policy Research, Japan 1991a; 2007, 2014) and junior high school (National Institute for Educational Policy Research, Japan, 1991b; 2016). MEXT has shared best practices of EE in school education among schools and teachers (MEXT, 2011). MEXT and the Ministry of Environment (MOE) have provided in-service teacher training on EE (Tokyo Gakugei University, 2005a, 2005b, 2005c). Now, almost all elementary schools in Japan practice environmental activities such as nature observation, protection of wildlife and plants, cleaning activities, waste sorting, recycling-related activities, and activities with biotopes. However, the MOE has not yet produced well-established official guidelines or curricula on EE for teacher training courses. A study reported that the teacher's guidebook on EE provided by the national government was not fully used in Japan (Tejima, 2005). Moreover, there are schools and teachers that cannot create an adequate EE curriculum or cannot implement the EE curriculum properly, and therefore, the quality of EE provided among schools and teachers varies widely (Tejima, 2005). The Science Council of Japan reported limited teaching methods and disparities in teachers' motivation for teaching EE as common challenges in schools (Science Council of Japan, 2008). To improve the quality of EE in schools, the Science Council of Japan suggested the following for EE teacher training: All pre-service teachers should be required to learn about EE including experimental activities in nature; the courses relating to EE in the professional schools for teacher training and those in the training for in-service

teachers should be improved both in quality and quantity and made compulsory. Moreover, the council emphasizes that EE should be positioned as a cross-curricular area in school education, and a full-time EE teacher should be assigned as a coordinator who can plan and envision the creation of a unit for environmental learning and cooperation with each subject (Science Council of Japan, 2008).

A study in Israel reported that environmental practices, perception of importance of EE in school, and environmental knowledge among students were significantly improved after conducting EE lessons in teacher training institutions (Yavets et al., 2009). However, research in the United States reported that EE was not institutionalized in pre-service teacher training courses in the majority of schools (McKeown-Ice, 2000). Moreover, the effect of EE lessons on college students' knowledge and awareness of the environment was limited, especially over time (Rideout, 2005). To develop the ability to teach EE among future teachers, appropriate EE should be provided in teacher training institutions (Science Council of Japan, 2008). Teaching of EE in teacher training college should focus not only on acquiring knowledge of environmental issues but also developing awareness, recognition and skills for teaching EE (North American Association for Environmental Education, 2000; United Nations Educational, Scientific and Cultural Organization, 1990). Therefore, this study aimed to develop an EE program, which can be incorporated into the teacher training curriculum as a compulsory subject and contribute to improving the ability and confidence of teaching EE among pre-service teachers in Japan.

2. Materials and methods

We reviewed relevant documents on EE and teacher training in EE. Then, on the basis of the review results, we developed an educational program for EE along with a rubric, from July to October 2012. We then implemented the program on a trial basis in a teacher training institution in Japan in November 2012. We evaluated the program by examining its appropriateness and clarifying future challenges.

2.1 Development of rubric and educational program for EE

To develop the rubric, we referred to a series of courses of study regarding EE in Japan (MEXT, 2008a, 2008b, 2008c, 2000d) and teaching guidelines for EE (National Institute for Educational Policy Research, 2007). We also reviewed documents on EE in Japan, such as educational reports (Tokyo Gakugei University, 2005a, 2005b, 2005c), and studies which clarified the teacher's role and competencies for practice of environment-related education in school (United Nations Educational, Scientific and Cultural Organization, 1977; United Nations Educational, Scientific

and Cultural Organization, 1990; Tokyo Gakugei, 2005a, 2005b, 2005c; North American Association for Environmental Education, 2000). In addition, we reviewed documents including published research papers, international reports and guidelines related to EE and teacher training on EE written in both Japanese and English. We used 'environmental education' and 'teacher' or 'competency' as key words for searching. We collected the documents by searching Google, Google Scholar, EBSCO, and Citation Information by National Institute of Informatics in Japan (a search engine for academic journals and university bulletins in Japan). Moreover, we reviewed courses of study for elementary and junior high schools, notices, manuals, and national reports published by MEXT or other university and research institutions in Japan. We used 'kankyou kyouiku' (environmental education), and 'kyouin' or 'kyoushi' (teacher) or 'kyouin yousei' (teacher training) as key words for searching. Where these key words appeared, we analyzed the information. In contrast, where only schools and teachers were the focus, we excluded the information. We aimed to develop a versatile rubric that could be applied to different specialty areas in education. EE researchers and those working in related academic fields such as health education, life sciences, technology and home economics education, and educational psychology discussed development of the rubric and teaching content in teacher training institutions. Based on the developed rubric, we designed an educational program as a compulsory lesson for first grade students.

2.2 Participants

The implementation of the educational program was on a trial basis, targeting all first-year students taking different subjects. During November 2012, we provided a series of four lessons in a teacher training institution located in a semi-rural area in Japan. The number of targeted students was 267 (132 males and 135 females).

2.3 Evaluation of the lessons

We set up a self-evaluation questionnaire on the website of the teacher training institution. This questionnaire was composed of four questions which represented four categories of the five in the developed rubric, namely, understanding of objectives and necessity of EE, knowledge about environmental issues, teaching methods of EE in the curriculum, and teaching methods of EE in school life and extracurricular activities (Table 1). Before starting the first lesson and after finishing the fourth lesson, the students were evaluated by the online questionnaire. For each question they were required to select the most appropriate choice from four suggested responses.

Table 1. Evaluation scale for the developed program

Categories	Evaluation scale	Score
1) Understanding of objective and necessity of EE	I know very little about the purpose or necessity of EE.	1
	I think I know the purpose and necessity of environmental education.	2
	I think that I can think about the purpose and necessity of environmental education in relation to the current school situation.	3
	I think I can explain the purpose and necessity of environmental education by associating it with the contents of teaching at the school.	4
2) Knowledge of environmental issues	I know few cases of environmental issues.	1
	I think I know some examples of environmental issues.	2
	I think that I can apply knowledge about environmental issues in relation to the current school situation.	3
	I think that I can use my knowledge about environmental issues by associating it with the contents of teaching at school.	4
3) Teaching method of EE in the class	I hardly know a concrete teaching method related to EE in the class.	1
	I think I know some specific teaching methods related to environmental education in the classroom.	2
	I think that I can apply a concrete teaching method related to EE in the class by relating it to the current school situation.	3
	I think that I can propose a concrete teaching method related to EE in the class by relating it to the current school situation.	4
4) Teaching methods of EE in school life and extracurricular activities	I know very little about specific teaching methods related to EE in school life.	1
	I think I know some specific teaching methods related to EE in school life.	2
	I think that I can apply concrete teaching methods related to EE in school life by relating them to the current school situation.	3
	I think that I can propose a concrete teaching method related to environmental education in school life by relating it to the current school situation.	4

Note: EE: Environmental Education; School life: Including yearly activities and individual life/health guidance

2.4 Data analysis

After excluding any missing values, we analyzed the data from 234 students with a response rate of 87.6%. In addition, the response data for the self-evaluated items were scored as shown in Table 1. Then, we carried out matched two-tailed t-tests to evaluate the differences between pre and post self-reported values.

2.5 Ethical considerations

This study was approved by the Research Ethics Committee of the Faculty of Education, Shinshu University in Japan (25-2). Before conducting the pre self-evaluation, we informed all participants about the purpose and procedures of the study. Then, we explained how the obtained data would be managed and that the results of the self-evaluation questionnaire would not affect credit earning of the lesson.

3. Results

3.1 Developed rubric for EE

Perspectives on evaluation of the developed rubric and comparison with competencies indicated in the international guidelines on EE (United Nations Educational, Scientific and Cultural Organization, 1990; North American Association for Environmental Education, 2000) are shown in Table 2. The United Nations Educational, Scientific and Cultural Organization describes required competencies for conducting EE, which are classified into two categories: fundamental competencies of the teaching profession and other competencies associated with EE content (United Nations Educational, Scientific and Cultural Organization, 1990). In addition, the North American Association for Environmental Education clarified the following six items needed for competence in EE: 1) environmental literacy, 2) foundations of EE, 3) professional responsibilities of the environmental educator, 4) planning and implementing EE, 5) fostering learning, and 6) assessment and evaluation (North American Association for Environmental Education, 2000). Both international guidelines indicate that teacher who teach EE have to acquire aspects of literacy and pedagogy, and thus the rubric and educational program were developed taking into account these two aspects set out in the international guidelines. In addition, the Thessaloniki Declaration emphasized the necessity of EE both inside and outside the school, and the importance of developing a teacher training program to facilitate EE (United Nations Educational, Scientific and Cultural Organization, 1997). The manual of EE teaching in the in-service training in Japan suggests the following teaching content: a lecture about basic concepts and the present EE situation; exercises involving experimental activities in the field; sharing examples of EE practice in school; participatory activities through workshops and group activities, and organizing exchange meetings (Tokyo Gakugei University, 2005b).

On the basis of the document review regarding the rubric and teaching content, we noted five main areas of evaluation for teaching of EE: 1) understanding of the objective and necessity of EE; 2) knowledge of environmental issues; 3) teaching methods of EE in the curriculum; 4) teaching methods of EE in school life and

extracurricular activities, and 5) teaching methods in specific subjects and cooperation with the community and other outside institutions. The rubric developed has two aspects: environmental literacy, such as understanding of environmental issues and mutual relationships between the environment and human health; and pedagogical aspects, such as introduction of EE practice in school, understanding of the teacher's role and required competencies for teaching EE in the classroom, and organizing environment-related activities in school and community. Moreover, we defined four different levels of achievement goals in each of the five categories (Table 3).

Table 2. Perspectives of evaluation of the rubric and comparison with competencies indicated in international guidelines on EE

Aspect	Developed rubric	UNESCO (1990)	North American Association for Environmental Education (2000)
Pedagogical aspect of EE	1) Understanding of objective and necessity of EE	Fundamental competencies in teaching profession	2) Foundations of EE
	3) Teaching method of EE in the curriculum 4) Teaching method of EE in school life and extracurricular activities 5) Teaching methods in specific subjects and cooperation with community and other outside institutions.		3) Professional responsibilities of the environmental educator 4) Planning and implementing EE 5) Fostering learning 6) Assessment and evaluation
Literacy aspect of EE	2) Knowledge of environmental issues	Competencies in EE content	1) Environmental literacy

Note: EE: Environmental Education; School life: Including yearly activities and individual life/health guidance

Table 3. Rubric for assessment of teaching skill in Environmental education for pre-service teachers

				Grade 1	Grade 2	Grade 3	Grade 4
			Objective for each grade	Know and understand what EE is.	Consider suitable contents of EE following current school situation.	Suggest plan of EE at school.	Implement EE teaching plan & practice combining specialty of each lecturer.
Category	Ref no. in EE teaching guideline *	Correspondence with developed EE program	Related subject in curriculum in the pre-service teaching	Liberal arts course EE	Observation practice	Teaching practice 1 Assessment of Pre/Post teaching practice	Teaching practice 2
1) Understanding of objective and necessity of EE	Chapter 1, Section 1 and 2	Lesson 1		Know the objective and necessity of EE.	Be able to link the objective and necessity of EE to the current school situation.	Be able to explain the suitable objective and necessity of EE related to the current school curricula.	Be able to suggest suitable plan and practice to achieve the objective and necessity of EE combining specialty of each lecturer.
2) Knowledge about environmental issues	Chapter 1, Section 3	Lesson 2 and 4		Know actual issues/problems related to environment.	Be able to link the knowledge of environmental issues to the current school situation.	Be able to apply the knowledge of environment issues to the actual school curricula	Be able to suggest a suitable plan and practice based on the latest / actual environment issues combining specialty of each lecturer.
3) Teaching method of EE in the curriculum	Chapter 2, Section 3	Lesson 2 and 3		Know suitable teaching methods for EE in the curriculum.	Be able to think of and select a suitable teaching method for EE.	Be able to suggest the actual teaching method plan of EE.	Be able to suggest suitable EE plan and practice based on the strategic teaching method combining specialty of each lecturer.
4) Teaching methods of EE in school life and extracurricular activities	Chapter 2, Section 3	Lesson 1, 2 and 3		Know a suitable teaching method for EE, which can be incorporated into school life.	Be able to think of and select a suitable teaching method for EE in school life.	Be able to suggest the actual teaching method plan of EE in school life.	Be able to suggest suitable EE plan and practice based on the strategic teaching method and current school situation, combining specialty of each lecturer.
5) Teaching methods in specific subjects and cooperation with community and other outside institutions		Lesson 2 and 3		Know the case examples of EE activities in cooperation with other organizations.	Have the specialty subject/knowledge about EE or environmental issues.	Be able to suggest the actual teaching method plan of EE using their own specialty subject/knowledge about EE or environmental issues.	Be able to suggest a suitable EE plan and implement related activities that cooperate with other organizations, based on the strategic teaching method and combining specialty of each lecturer.

* Ministry of Education, Culture, Sports, Science and Technology, Japan. (2007)

Note: EE: Environmental Education; School life: Including yearly activities and individual life/health guidance

The developed rubric indicated the relationships between a suggested category and the contents in the EE teaching guideline (MEXT, 2007). The rubric also indicated relationships between suggested categories and subjects in the current curriculum of the university.

3.2 Developed educational program for EE

The educational program consisted of four lessons, with each one lasting for 90 minutes. The objectives and main content of the program are shown in Table 4. The program had two aspects as mentioned in the rubric: an aspect focused on environmental literacy which is taught in lesson 2, and an aspect on pedagogy of EE taught in lessons 1, 3, and 4.

Table 4. Objectives and main content of four lessons in the newly developed program

	Objectives of the lesson	Content of the lesson
Lesson 1	Students be able to - explain about objectives and necessity of EE - understand about individual differences of sense of value on environmental behaviors - increase motivation for EE teaching.	・Objectives and necessity of EE ・Introduction to Beograd charter ・Exercise about EE (workshop) involving Japanese board game (Environmental Sugoroku), group discussion on environmental issues, and discussion of environmentally friendly behavior that students can tackle.
Lesson 2	Students be able to - explain actual issues / problems related to the environment - explain suitable teaching methods for EE in the curriculum - explain the case examples of EE activities in cooperation with other organizations.	・Introduction to environmental problems in Japan and the world with underlying reasons for the problems occurring and influence on society. ・Concrete examples of EE activities in school life ・Concrete examples of EE activities in cooperation with other organizations.
Lesson 3	Students be able to - explain suitable teaching methods for EE which can be incorporated into school life.	・Competence for EE teaching as a teacher in lessons and school life ・Example of teaching methodology for EE
Lesson 4	Students be able to - explain about relationships between environment and health and also health problems which are related to environmental problems.	・Environment and health: health problems which are related to environmental problems.

Note: EE: Environmental Education; School life: Including yearly activities and individual life/health guidance

We also introduced different kinds of teaching methods for EE with activities including a Japanese board game (Environmental Sugoroku), and group discussions of

environmental issues and environmentally friendly behaviors that students themselves can adopt.

3.3 Outcomes following the program

Following the program, all four values measured through self-evaluation increased, and in particular, confidence to teach EE in the school increased significantly. Self-evaluation by students about the outcomes of the program is shown in Table 5. Regarding the objectives and necessity of EE, the post self-evaluation data was significantly higher than the pre self-evaluation data ($t=12.06$, $p<0.001$, $d=0.79$). Regarding knowledge of environment, the post self-evaluation data was also significantly higher than pre self-evaluation data ($t=8.51$, $p< 0.001$, $d=0.56$). For teaching method of EE in the class, again, post self-evaluation data was significantly higher than pre self-evaluation data ($t=12.15$, $p<0 .001$, $d=0.80$). Teaching methods of EE in school life and extracurricular activities also revealed post self-evaluation data that was significantly higher than pre self-evaluation data ($t=12.60$, $p<0.001$, $d=0.83$).

Table 5. Self-evaluation by students about the outcomes of the program

Categories	Evaluation scale	Score	Percentage		Mean of score ±SD		
			Pre	Post	Pre	Post	*p-value*
1) Understanding of objective and necessity of EE	I know very little about the purpose or necessity of EE	1	42.5%	5.7%	1.8± 0.8	2.5± 0.7	**
	I think I know the purpose and necessity of environmental education	2	38.9%	46.3%			
	I think that I can think about the purpose and necessity of environmental education in relation to the currents school situation	3	17.6%	41.1%			
	I think I can explain the purpose and necessity of environmental education by associating it with the contents of teaching at the school.	4	1.2%	7.0%			
2) Knowledge of environmental issues	I know few cases of environmental issues	1	7.8%	1.2%	2.1± 0.5	2.5± 0.7	**
	I think I know some examples of environmental issues	2	79.2%	59.8%			
	I think that I can apply knowledge about environmental issues in relation to the current school situation	3	11.0%	29.7%			
	I think that I can use my knowledge about environmental issues by associating it with the contents of teaching at school	4	2.0%	9.4%			
3) Teaching methods of EE in the class	I hardly know a concrete teaching method related to EE in the class	1	54.3%	12.6%	1.6± 0.7	2.3± 0.8	**
	I think I know some specific teaching methods related to environmental education in the classroom	2	36.3%	53.3%			
	I think that I can apply a concrete teaching method related to EE in the class by relating it to the current school situation	3	8.2%	25.6%			
	I think that I can propose a concrete teaching method related to EE in the class by relating it to the current school situation	4	1.2%	8.5%			
4) Teaching methods of EE in school life and extracurricular activities	I know very little about specific teaching methods related to EE in school life	1	48.6%	9.7%	1.6±0. 7	2.4± 0.8	**
	I think I know some specific teaching methods related to EE in school life	2	39.2%	50.0%			
	I think that I can apply concrete teaching methods related to EE in school life by relating them to the current school situation	3	11.4%	32.1%			
	I think that I can propose a concrete teaching method related to environmental education in school life by relating it to the current school situation.	4	0.8%	8.1%			

Note: EE: Environmental Education; School life: Including yearly activities and individual life/health guidance; $p<0.01$**

4. Discussion

This study aimed to develop a rubric and EE program as a compulsory subject for the teacher training curriculum in Japan. Results were analyzed to elucidate future challenges for developing the program. The rubric clarified perspectives on evaluation for teaching EE and specified required knowledge and technical skills in each grade in accordance with expected professional development as a teacher, among pre-service teachers. The program consisted of the introduction of EE in school, understanding the teacher's role and required competencies for teaching EE lessons, and organizing school and community activities to enhance understanding of environmental issues. Moreover, we introduced different kinds of teaching methods for EE including a Japanese board game (Environmental Sugoroku) and group discussions on environmental issues and changes to behavior that students themselves could use to support more sustainable living. Results of the trial demonstrated the appropriateness and effectiveness of the program, confirming that all four values increased in the self-evaluation when pre and post results were compared.

A review of EE research emphasized the necessity of providing both subject and pedagogical aspects appropriately to pre-service teachers for promoting the teaching of EE in school, and providing environmentally literate teachers and securing the professional competencies of an environmental educator (Alvarez-Garcia et al., 2015). The rubric and educational program consisted of two aspects: environmental literacy and the pedagogical aspect of EE.

To date, many studies have examined students' awareness, knowledge and interest in environmental issues (Alvarez-Garcia et al., 2015; Miles et al., 2006; Pe'er et al., 2007; Tuncer, 2009; Ull, 2014 ; Vlaardingerbroek, 2007). Moreover, the effectiveness and challenges of educational interventions on improving knowledge and interest in environmental issues in teacher training institutions have been reported (Rideout, 2005). Bluhm and Hungerford (1976) reported that introducing an EE teaching model in pre-service training improved students' perception of EE and their understanding of ecological concepts. However, the effect of pre-service educational interventions focused on understanding the role of the EE teacher, the importance of EE and ways to improve self-confidence when teaching EE, has not been fully clarified. Previous interventions have not focused on improving the pedagogical aspect of EE teaching. In the present study, we targeted both environmental literacy and pedagogical aspects of EE. We confirmed significant improvements in understanding the objectives and need for EE, knowledge about environmental issues, teaching

methods of EE in the curriculum, and teaching methods of EE in school life and extracurricular activities.

Álvarez-García et al. (2015) pointed out the need to introduce training models that cover both environmental competencies of teachers and give teachers a sufficient pedagogical background to transform these environmental competencies into teaching skills and capacity for EE. In this context, this study proposed a concrete example of a training model that includes both environmental literacy and pedagogical aspects for implementing EE in schools, in a teacher training institution.

The importance of EE in teacher training to produce effective EE teachers has long been recognized as the 'Priority of priorities' (United Nations Educational, Scientific and Cultural Organization &- United Nations Environment Programme, 1990). In addition, adequate preparation of pre-service teachers in EE is a prerequisite for students to design and implement effective EE (Goldman et al., 2006). Research indicates that the greatest barrier to implementing EE at teacher training institutions is that their curriculum does not allocate enough time for EE (McKeown-ice, 2000). EE is not prioritized as an essential subject (McKeown-ice, 2000; Mastrilli, 2005; Heimlich, 2004; Van Petegem, 2007). To address this issue, this study positioned the developed educational program as a compulsory subject for pre-service teachers expecting that the developed EE program for teacher training will be continually implemented.

However, the study had several limitations. First, we obtained only data from self-evaluation by students. Data from objective evaluations, such as levels of understanding and participation in the lessons, might provide additional insights in the analysis. Second, this study evaluated the results in a single fiscal year. Although long-term impact was beyond the scope of this study, conducting evaluation over a longer timeframe might provide further insights to understand the effectiveness and appropriateness of the educational program. Third, qualitative outcomes of the educational program were not analyzed in this study. Future research is needed to clarify factors related to the improvement of rubric scores. Fourth, the educational curriculum did not include issues on Education for Sustainable Development (ESD). The importance of promoting ESD has increasingly been recognized. Summers, Childs and Corney (2005) reported the effectiveness of integrating ESD in schools into the subjects of the pre-service elementary teacher curriculum by adopting an interdisciplinary approach. Further study is needed to integrate the EE program developed in this research with ESD issues in the curriculum in pre- service training.

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Declaration of interest statement

The authors declare no conflicts of interest associated with this manuscript.

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