



Contents lists available at ScienceDirect

Sustainable Environment Research

journal homepage: www.journals.elsevier.com/sustainable-environment-research/

Original Research Article

Measuring the effect of environmental education for sustainable development at elementary schools: A case study in Da Nang city, Vietnam

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ARTICLE INFO

Article history:

Received 23 December 2015

Received in revised form

15 April 2016

Accepted 7 June 2016

Available online 26 August 2016

Keywords:

Environmental education

Solid waste management

Elementary school

Da Nang city

Vietnam

ABSTRACT

This study provides a detailed description of the environmental education of elementary school students in Da Nang city, Vietnam. In January 2014, the study surveyed 247 students in two elementary schools. An evaluation of the students' knowledge of solid waste management was conducted. Students had basic knowledge about the environment, but their knowledge was limited with regard to solid waste management. In February 2015, an environmental education workshop was conducted for the students. The result showed that 96% of the students were interested in solid waste management activities. In addition, the study found that there were changes in the students' knowledge before and after environmental education activities. Before the activity 29% of the students said that they knew about eco-bags, and 55% of the students said that they knew "that plastic bags are difficult to decompose naturally." After environmental education 87% of the students answered that they knew about eco-bags, and 71% of the students said that they knew "that plastic bags are difficult to decompose naturally." Given these results, this study was successful in increasing students' knowledge about solid waste management.

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1. Introduction

According to a World Bank report written by Hoornweg and Bhada-Tata [1], it is estimated that the world generates around 1.3 billion tons of waste per year. With increasing urbanization, it is expected to reach 2.2 billion tons per year by 2025 – an increase of 70%. As a key component in municipal solid waste (MSW) management, the landfill is important especially in upper- and lower-middle-income countries. Countries have been grouped according to their Gross National Income (GNI) as high (GNI > US\$12,615), upper-middle (US\$4086 < GNI < US\$12,615), lower-middle (US\$1036 < GNI < US\$4085), and low (GNI < US\$1035) incomes. GNI per capita is estimated using the World Bank Atlas method [2]. Sanitary landfilling is one of the best ways to decrease the volume of waste products [3]; nevertheless, the lack of suitable land for landfill sites is a major issue [4]. Therefore, to extend the life of a

landfill site, waste reduction at the source is a critical aspect of MSW management. In this paper, upper- and lower-middle-income countries will be referred to as middle-income countries. Poor waste management practices are a common and growing problem facing middle-income countries. Middle-income countries such as Vietnam have experienced great challenges in solid waste management, not only in the collection, transfer, and final disposal of waste, but also a lack of public awareness of the solid waste system, haphazard urbanization, the introduction of environmentally unfriendly materials, and changing consumption patterns. With a total area of 331,210 km², Vietnam is one of the most densely populated countries in Southeast Asia. In July 2015, the population was estimated to be approximately 94 million. Vietnam demonstrates the fourth highest population growth rate in Southeast Asia, at 0.97%, after Singapore (1.89%), Malaysia (1.44%), and the Philippines (1.61%) and followed by Indonesia, at 0.92% [5]. Approximately 33.6% of the country's residents live in cities with annual urbanization rates of 2.95% [6]. Therefore, solid waste is a growing problem especially given that urban populations are continually increasing. The country is producing more than 15 million tons of waste each year and this volume is expected to grow

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Peer review under responsibility of Chinese Institute of Environmental Engineering.

rapidly over the next decade. The waste generation rate in Vietnam is $0.63 \text{ kg cap}^{-1} \text{ d}^{-1}$ [7]. That is not as high as other countries in Southeast Asia such as Malaysia, at $0.98 \text{ kg cap}^{-1} \text{ d}^{-1}$, or Singapore, at $0.94 \text{ kg cap}^{-1} \text{ d}^{-1}$ [7]. It is estimated that the average urban resident in Vietnam produces about twice the amount produced by people in rural areas. Urban areas account for more than 80% of MSW (12.8 Mt yr^{-1}). Solid waste in urban areas is composed mainly of food waste, paper, plastic, wood, metal, and glass, with some hazardous household wastes such as fluorescent lights and batteries [8]. Currently there is no effective publicly organized recycling in Vietnam, as no official waste separation and recycling systems exist in the country except for some pilot projects. In its large cities Vietnam has one of the best organized garbage collection and dumping systems among the lower-middle income countries in Southeast Asia. The problem in Vietnam is the lack of an official separation and recycling policy. Implementation of such a policy requires participation by every citizen. Therefore, education in solid waste management is important. The government has been trying to implement a waste separation and recycling policy throughout the country (June 1998, Decision No. 36-CT/TW), but has not yet succeeded, mainly due to a lack of funding and human resources in the public sector [9].

Vietnam has experienced increased levels of environmental pollution, in line with rapid socioeconomic development and urbanization in recent years despite the Law on Environmental Protection, which was established in January 1994. Amendments to the law known as “Vietnam Agenda 21,” with aim at sustainable development, were made by the Prime Minister on August 17, 2004. The amendments were passed into law in July 2006. Within the “Vietnam Agenda 21” of the environmental protection policy, the “3Rs initiative” of reduce-reuse-recycle has been introduced as an important method that should be monitored, adopted, and promoted by the government. Table 1 contains a summary of the environmental policy, law, and agendas in Vietnam.

Da Nang city is one of the major port cities in Vietnam, in addition to Ho Chi Minh City and Haiphong city, and the largest city on the south central coast of Vietnam. The administrative area of the city is composed of six districts and two suburban districts, one of which is an island suburb with an area of 305 km^2 . The total area of Da Nang city is 1285 km^2 . The population in the city is 951,680 with a large part traveling in from other municipalities to work. From 2002 to 2011, the population in Da Nang city increased approximately 1.3 times [11].

The Da Nang city People's Committee committed to and promulgated a comprehensive environmental plan for Da Nang City in August 2008 called “Building Da Nang City as An Environmental City (No. 41/2008/QĐ-UBND)”. It sets a 2020 target for many different environmental issues such as air pollution reduction, waste treatment and recycling, energy conservation, and renewable energy. The plan is based on Agenda 21 of the Vietnamese government (Prime Minister's Decision No. 153/2004) and Vietnamese Environmental Standards 2, where 2020 is set as the target year. The general goals for the Environmental City Plan are to: (1) Provide a safe and healthy environment for people, assuring land, water, and air quality; (2) Prevent environmental pollution and degradation; and (3) Make the people of Da Nang city aware of environmental protection and Da Nang's development as an environmental city [11].

According to the Da Nang city Urban Environmental Company, the waste management company disposed at Khanh Son Landfill 700 to 750 t d^{-1} on average of MSW collected from Da Nang city, representing a collection ratio of 90% in 2012 [12]. From the information provided by the Japan International Cooperation Agency in Vietnam featured in the report by the Vietnam Ministry of Natural Resources and Environment, MSW in Da Nang city was composed of 68.5% food waste, 5.1% paper, 2.9% cloth, 2.8% wood, 11.4% plastic, 0.1% glass, 1.5% metal, < 0.1% hazardous waste, and 3.2% other waste [12]. With its designed capacity, the Khanh Son

Table 1
Environmental legislation regarding solid waste management in Vietnam.

Date	Name	Details
April 9, 2007	Decree No. 59/2007/NĐ-CP	The Government's promulgation of the regulation on solid waste management activities, and the rights and duties of persons related to solid waste management
August 9, 2006	Decree No. 81/2006/NĐ-CP	The Government's promulgation of the regulation of sanctions against administrative violation in the field of protection of the environment (replaces decree No. 121/2004/NĐ-CP)
August 9, 2006	Decree No. 80/2006/NĐ-CP	The Government's detailing of the implementation of the law on environmental protection
November 29, 2005	Law on Environmental protection	Took effect July 1, 2006 (replaced the Environmental protection law 1993)
August 17, 2004	Decision No. 153/2004/QĐ-TTg	The Prime Minister's decision on the provision of sustainable development in Vietnam
December 2, 2003	Decision No. 256/2003/QĐ-TTg	The Prime Minister's decision on approving the national strategy on environmental protection up to the year 2010 and vision to the year 2020
April 22, 2003	Decision No. 64/2003/QĐ-TTg	The Prime Minister's approval of the plan for managing establishments causing serious environmental pollution
June 25, 1998	Decision No. 36-CT/TW	The Central Committee of the Communist Party of Vietnam's steering of further promotion of environmental protection
December 27, 1993	Decision No. 29-L/CTN	The Prime Minister's provision of the law to protect the environment
Legislation on recycling		
April 2, 2004	Decision No. 03/2004/QĐ-BTNMT	The Ministry of Natural Resources and Environment's decision on importing waste as materials for domestic production
May 6, 2002	Official Letter No. 1146/BKHCHNMT-MTg	The Ministry of Science, Technology, and Environment's approval of the National Action Plan for Cleaner Production
Standards		
	TCXDVN 320-2004	Standard for designing hazardous waste landfills
	TCVN 7241-2003	Standard for determining dust concentration in flue gas in health care solid waste incinerators
	TCXDVN 261-2001	Standard for designing landfills.
	TCVN 6707-2000	Standard for prevention and warning signs for hazardous waste
	TCVN 6706-2000	Classification of hazardous solid waste
	TCVN 6705-2000	Classification of non-hazardous solid waste
	TCVN 6696-2000	Requirements for environmental protection for sanitary landfills

Landfill will be closed by 2020. In Da Nang city, there is an urgent need for reduction, reuse, and recycling measures for MSW. Recently, there are some projects in Da Nang city for sustainable solid waste management, such as the Eco-city project at Cam Le district, and the composting of agricultural waste at the Hoa Vang suburban prefecture [12]. In addition, there is a traditional food waste collection system where farmers collect and use food waste to feed pigs [13–15].

In Southeast Asia, solid waste is one of the most hotly debated environmental issues. Education in solid waste management is becoming an important tool in Southeast Asia to solve the environmental pollution problem [7]. MSW education projects have started in Southeast Asian countries as shown in Table 2. Examples

include the 3R project in Ha Noi, Vietnam [16], community-based waste management in Surabaya, Indonesia [17], and the school waste bank in Thailand [23]. There is a growing need for MSW education for children in middle-income countries in Southeast Asia. However, the implementation of MSW education for young children is limited in most countries in this region. In particular, education in solid waste treatment is rarely done in elementary schools in Vietnam.

In developed countries, long-term environmental education is considered to be an effective method for increasing environmental awareness among children. Such programs include early childhood care and education at New Brunswick, Canada [24], working towards sustainable schools in Gothenburg, Sweden [25], and

Table 2
Solid waste management education projects in Southeast Asia.

Country	Social and environmental status and issues ^{a,b}	Project stakeholders	Project instruments	Project targets
Vietnam: Pilot project at Ha Noi [16]	GDP growth rate (%/year): 6.1% (2015) Urbanization: 30.4% (2010) Rate of consumption Law and enforcement Budgets Public objections Efforts for large-area policy discussion Financial	University students Local residents Elementary students	Source separation in model areas Recycling of organic waste into compost PR and environmental education activities Developing a strategy and action plan.	To let residents become familiar with a 3R system based on a source separation program of organic waste To let residents in model project areas think more about the benefits of using eco-bags
Indonesia: Pilot project at Jakarta city, Semarang, Surabaya, Bandung [17]	GDP growth rate (%/year): 5.5% (2015) Urbanization: 44.3% (2010) Rate of consumption Law and enforcement Budgets Public objections Efforts for large-area policy discussion Financial	Communities	Education activities for citizens Questionnaires Efforts for large-area policy discussion	To improve the garbage disposal system in Central Jakarta To reduce waste To extend landfill life To increase waste collection To reduce emission of greenhouse gases
Thailand: Pilot project at Sakonnakorn province, Bangkok [18]	GDP growth rate (%/year): 3.6% (2015) Urbanization: 34.0% (2012) Rate of consumption Law and enforcement Budgets Public objections	Students Communities	Questionnaires Reduction and recycling activity Training programs and practical guidelines Provision of clear procedures and guidelines Regular town hall meetings between citizens and local government officials	Waste reduction Cost savings for management Extending landfill life Supply-side management
The Philippines: Pilot project at the University of the Philippines [19]	GDP growth rate (%/year): 6.4% (2015) Urbanization: 48.9% (2010) Rate of consumption Law and enforcement Budgets Public objections Landfill problems Solid waste management problem	Children of all ages Teenagers Household help Parents The elderly	Questionnaires Seminar tests Attitude scales Interview guides	Developing the knowledge, skills, and attitudes of the members of the community towards proper handling of waste
Malaysia: Pilot project of a university in Malaysia [20]	GDP growth rate (%/year): 4.7% (2015) Urbanization: 72.2% (2010) Rate of consumption Law and enforcement Budgets Public objections Landfill problems	Office staffs Students Lecturers Hostel operators Canteen operators Building custodians Outdoor cleaning and landscape workers Security guards	Two-hour training of solid waste management on the university campus Zero Waste Club: Participation in collection and recycling in campaigns and activities associated with zero-waste activities Position for providing strong leadership and examples for the development of sustainable communities, by conducting programs for future leaders	Reducing waste production Increasing and maintaining participation in recycling and composting schemes within the university Raising and maintaining awareness of waste issues Promoting the waste hierarchy: reduce, reuse, recycle Providing a diverse range of ways to increase education and awareness Consistent publicity Linking in with regional and national campaigns

^a GDP growth rate due to [21].

^b Proportion of urban population due to [22].

learning and ecological activities in Nishinomiya, Japan [26]. However, building long-term environmental education programs always requires time, along with an associated budget. In middle-income countries with limitations in resources, budget, school facilities, and teaching staff, long-term environmental education is not presently suitable. Short-term education that requires minimal resources is a realistic solution for dealing with environmental problems in middle-income countries. Vietnam does not have a regular program to teach students about MSW management, apart from pilot projects in some large cities, such as the 3Rs project in Ha Noi city. This project had some environmental education classes for university students who were interested in environmental protection. This project had been in effect for three years from 2006 to 2009 in four districts in Ha Noi that were selected to conduct a pilot project on source separation of organic waste and production of organic fertilizer. They were Ba Dinh, Hoan Kiem, Hai Ba Trung, and Dong Da District. As a pilot project with source separation of organic waste in the selected model districts, a new waste collection system suitable for collecting source-separated waste was introduced instead of a traditional one. Under the new collection system, citizens had to dispose of organic waste in a green-colored bin and inorganic waste in an orange-colored bin, from 6 to 8 pm at designated sites. The project has succeeded by involving a variety of stakeholders in the process of implementing source separation, composting, environmental education, and raising the awareness of citizens [27]. However, the 3Rs project in Ha Noi is not always an appropriate model for other cities in Vietnam. For example, Da Nang city does not have a composting plant like the plant that played a central role in the Ha Noi 3Rs project.

This study aims to evaluate the effects of environmental education at elementary schools in Da Nang city that provides knowledge of solid waste management problems due to improper treatment of waste, as well as the benefits of recycling. The objectives of this study are to evaluate the present status of environment knowledge including MSW management among elementary school students and to conduct short-term MSW management education for fifth-grade students as well as evaluating its effects among the students.

2. Methodology

Our survey and experimental environmental education were done in three elementary schools in two districts of Da Nang City. Ong Ich Khiem School (school 1) and Le Dinh Ly School (school 3) were chosen from the Hai Chau District (HC), and Dung Si Thanh Khe school (school 2) was chosen from the Thanh Khe District (TK). These schools were chosen through the following procedure. First, we excluded the schools where the highest or lowest level of education was done in the area. Second, we randomly chose five schools in the HC and TK districts. Third, one of the authors visited five schools and asked for the school principal to participate in our survey. Two schools joined our survey, but the other three schools refused to join because of security concerns. School 3 was suggested by the leader of school 1, and we used the students of school 3 as the control group for our experimental environmental education. Fig. 1 shows the locations of these schools. HC is well known as the important district in Da Nang city. The city hall, main theater, and main market are located in this district. TK is farther than HC from the center and has the second largest population among the districts in Da Nang city.

From the start, the study aimed to understand the present state of students' knowledge and behavior with respect to the environment. Hence, the questionnaires were developed from Vietnamese elementary textbooks. Vietnamese elementary schools use the same textbooks throughout the country from 1st through 5th

grades. First, the study extracted the keywords that were related to environmental issues from the three textbooks of science, technology, and ethics used by 4 and 5th graders. Table 3 provides summaries of Vietnam elementary textbooks. Second, the study sorted the keywords from the three textbooks into six environmental issues: waste separation, food waste, environmental knowledge (soil, water, air, and forests), electricity and water supply, climate change, and disaster and other questions focusing on environmental education. We found that the elementary textbooks did not contain any information about solid waste management like waste separation and food waste. Thus, we added these elements. Third, the questionnaires were formatted to acquire students' knowledge in these six areas.

This study focused on solid waste management education, especially food waste. Our surveys contained questions about the eco-bag, plastic bags, the food waste collection system, and the food waste treatment system that was contained in survey 2. According to the Vietnam Ministry of Natural Resources and Environment, eco-bags are bags that can replace plastic bags and are safe for the environment, such as paper bags and cloth bags [8]. The eco-bag is used by all of the big supermarkets in Da Nang city. Food waste recycling for feeding pigs is commonly practiced in the city [13–15]. The waste separation and food waste questions were addressed in survey 3 and followed the students' daily life activities.

This study provided four questionnaire surveys to the students of the elementary schools indicated in Fig. 2. The students were separated into two groups. Group 1 was the main body of the research. We recruited four classes of 4th grade students at both school 1 and 2, and we followed these students for one year. In Vietnam, elementary schools end at the 5th grade. During this period, we conducted four surveys and one environmental education activity with these students. Group 2 involved students from school 3; these students took our last survey only for the purpose of comparison. The students had answered the questionnaires in their classrooms. One of the authors came to the school and together with the class teacher gave questionnaire surveys to the students. The second author was present in the 5th graders' classes 1 and 3 (hereafter classes 5.1 and 5.3) at school 1 in survey 3. Normally, students had 15 min at break time to answer the questionnaire surveys. Teachers expanded this time by another 15 min if the students had not finished after 15 min. The students had a maximum of 30 min to answer the questionnaire surveys in their classrooms.

The study considered Piaget's theory [28] and chose the 4 and 5th grade elementary students as our subjects for this study. Piaget's theory [28] can help educators understand how children react and learn according to their age. In Piaget's research, the main goal was to answer the question, "How does knowledge grow?" He did this using genetic epistemology, which is the study of cognitive development in children. There are four major stages in a child's cognitive development: sensorimotor, preoperations, concrete operations, and formal operations [29]. A child's thought process at one stage is different from other developmental stages, and each of the stages has its own importance. With concrete operations (ages 7–11), as physical experience accumulates, the child starts to conceptualize, creating logical structures that explain his or her physical experiences. Abstract problem solving is also possible at this stage. We think that 4th or 5th grade is a good age to start environmental education.

Our experimental education and questionnaire surveys were conducted immediately after the final examination of each semester for the 4th and 5th grade students. The final examinations are scheduled in late January and early May. It was difficult for the schools to provide time for our activity during the regular lecture periods. We expected that the students could focus on answering our survey if it was done after the final examination rather than

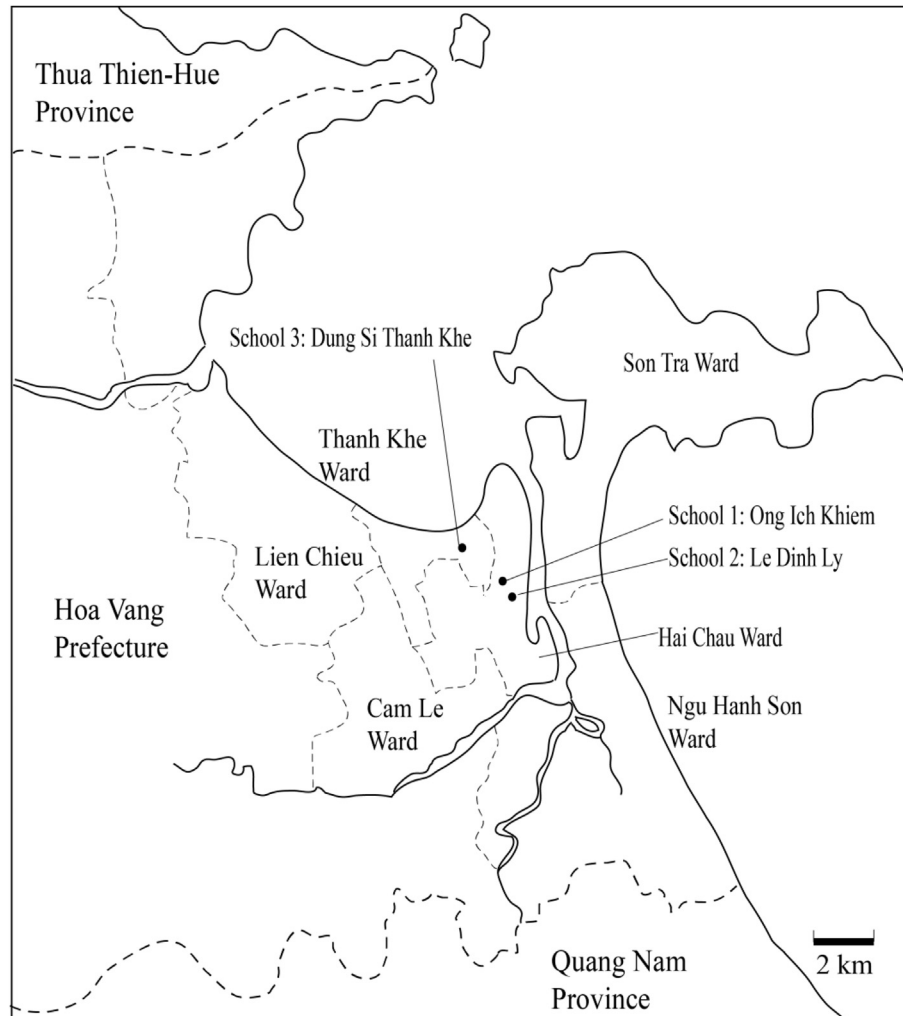


Fig. 1. Locations of surveyed schools.

before. Some of the regular lectures during this two-year period were relevant to environmental issues. In particular, the school-teachers held lectures on water pollution, air pollution, typhoon protection, and environmental protection for a total of nine hours during the first semester for 4th graders.

2.1. Survey 1 from January 22 to February 4, 2014

The aims of this survey were to understand the status of environmental knowledge among group 1 students. To achieve this, survey 1 involved a total of 372 students from the 4th grade. Students answered 32 questions from the questionnaire.

2.2. Survey 2 from May 19 to May 30, 2014

The second survey evaluated the knowledge and skills of students in solid waste management. This questionnaire survey 2 measured the baseline knowledge level of the group 1 students.

2.3. Survey 3 from March 2 to March 18, 2015

Our short-term environmental education activity in March 2015 provided opportunities for the group 1 students to (1) join a waste separation game, (2) learn basic concepts of solid waste

management and the present status of voluntary food residue recycling in Da Nang city, and (3) answer questionnaire survey 3 to assess the impact of the environmental education.

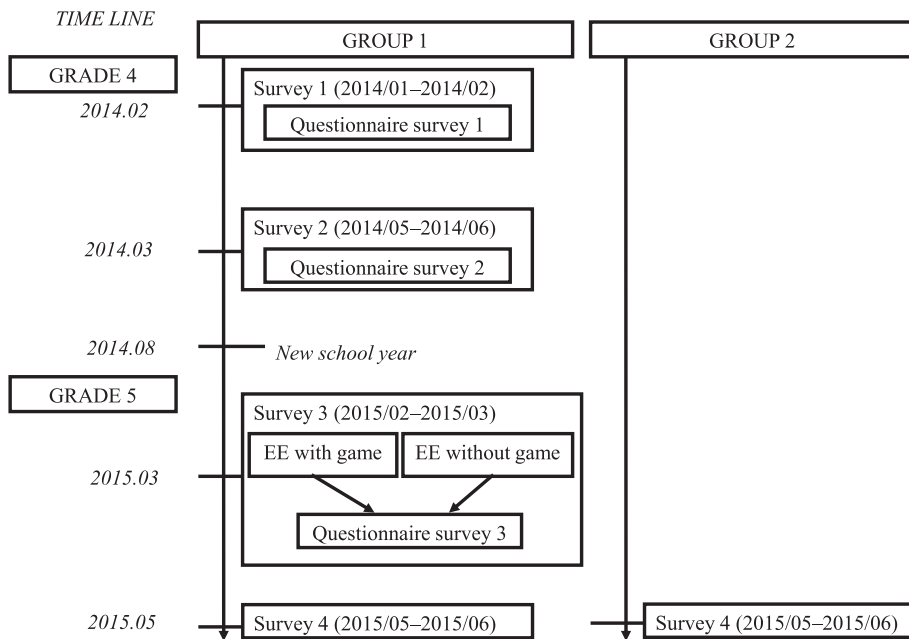
Fig. 3 shows the poster used in our environmental education activity. This poster contains basic information about organic and inorganic waste, as well as recyclable or reusable waste. We referred to the separation categories shown in a guidebook for the 3Rs project in Ha Noi city [30] and slightly modified the categories to meet the needs of using food waste to feed pigs.

- Organic waste is waste composed of easily biodegradable compounds (decomposition under natural conditions). Simply, organic waste is derived from organisms (plant and animal).
- Inorganic waste consists of two kinds of waste, (1) inorganic waste and (2) recyclable or reusable waste.
 - (1) Inorganic waste includes glass, porcelain, old clothes, coal, tissue waste, plastic bags, toys, and cigarette waste.
 - (2) Recyclable or reusable waste is not true waste but more of a resource that can be reused, such as cans, bottles, newspapers, and clothes.

In addition, the poster contained pictures that showed food waste collection and eco-bag systems in Da Nang city. The poster contained concepts of 3Rs. At the end of the environmental

Table 3
Environmental issues in Vietnamese elementary textbooks.

Grade	Book	Lesson	Contents
1	Natural and social study	17	Clean school and class
		22–24	Plants
		25–28	Animals
2	Ethics	29	Recognize plants and animals
		14	Protect plants in public areas
	Natural and social study	13	Protect environment around area where we live
		18	Practice: Keep school and class clean
		24–26	Where plants live
		27–29	Where animals live
3	Ethics	30	Recognize plants and animals
		14	Protect animals
	Natural and social study	36–38	Protect environment
		40–55	Natural environment
		56–57	Internship: Visit natural environment
4	Ethics	13	Save and protect water
		14	Protect plants and animals
	Science	25	Water pollution
		26	Causes of water pollution
		27	Some ways to make water clean
		28	Protection of water resources
		29	Save water
		38	Wind, Typhoon protection
		39	Air pollution
		40	Protection of air
		5	Technology
13	Take care of vegetables and flowers		
Ethics	14		Protect environment
	41		Sun power
Science	42–42		Fuel power
	44	Wind power and water power	
	45	Electrical power	
	48	Save energy	
	62	Environment	
	63	Natural resources	
	64	Importance of environment to human life	
	65	Impact of humans on forest	
	66	Impact of humans on soil	
	67	Impact of humans on air and water	
Technology	68	Some measures to protect environment	
	10–15	Technical taking care of chickens	
	Ethics	14	Protection of natural resources



NOTE:
EE: Environmental education

Fig. 2. Research structure.



Fig. 3. Poster used for environmental education.

education, the students received a notebook whose cover was a picture of the poster. In addition, Table 4 shows a comparison between this study's environmental education and three other environmental education activities done in solid waste management. In elementary classes, students have 45 min per lesson, and for this reason, we chose to make the activities around 30 min in each class. As mentioned in the school selection section, it is difficult to get

permission to enter and conduct activities in elementary schools. School principals allowed the study during one free lesson that students have every week. In addition, the elementary schools do not allow students to go outside of the school to attend environmental education. Recently, the elementary classes have had around 40 to 50 students, so it is quite difficult for teachers to accompany students outside.

Table 4
Summaries of environmental indoor education games.

Game	Separation garbage game (this study)	Shadow play and animation as methods for ESD game	Trash art game	Weigh your waste
Grade	5th grade	5–9th grade	2–3rd grade	4–6th grade
Time	30 min	3–4 h	1 h	1 to 2 h, with periodic discussions over the course of a week
Material	Poster Waste pictures (5 organic waste pictures, 5 inorganic waste pictures) Baskets (White – organic waste, green – inorganic waste)	iPad or iPhone Stop motion studio app Cardboard, playdough etc. for making the characters A camera stand and a mount for the iPad makes things easier but is not mandatory	One copy of “Parents Note” for each student One tarp or drop cloth 10 to 12 magazines (with lots of everyday product advertisements) “Clean” garbage (brought in by students) Art supplies (enough for class): - Three to four sheets of colored construction paper per student - Glue - Tape - Scissors - Markers or crayons - Glitter	One trash bag per student One twist-tie garbage bag fastener for each student One 3- by 5-inch note card per student One plastic tarp • One set of gloves per student One scale One copy of “My Trash Journal” for each student Clear tape
Reference	This study	[31]	[32]	[32]

Timeline (min)	Treatment 1	Treatment 2
1	Greeting	
6	Make group - 1 group: 6 students (1 class: 8 groups)	
	Short speech about typhoon	Environment game - We will make 10 cards about waste (5 cards are organic waste, 5 cards are Inorganic waste). - Group student will separate 10 cards to dust box (organic waste and Inorganic waste). - We will tell student how many cards are they in right dust box.
20	Environmental education about solid waste management. - We will make teaching material in A0 paper. We will do the same teaching for students.	
25	Break time	
30	Question time, clean up class and answer check list about activities	

Fig. 4. Timetable for environmental education.




Fig. 4 is the timetable for the environmental education, which took 30 min in the classroom. Students were randomly separated into two treatment groups: treatment group 2 participated in a waste separation game, and treatment group 1 had no environmental game playing. For treatment group 2, students played a 10-min game at the beginning of the session. In treatment group 1, students studied about planning typhoon disaster for the first 10 min. In this activity, one class was divided into eight small groups (five to six students per group). After the environmental education class, the “activity evaluation sheet” was distributed to students. It could help to evaluate the quality of the activity (see Fig. 5). The “activity evaluation sheet” was given to students to understand their feelings and ideas about environmental education. The results from the “activity evaluation sheet” will provide

information for improving environmental education that will be applied in the near future. Two days later, students answered questionnaire survey 3 by a self-administered method.

2.4. Survey 4 from May 18 to May 29, 2015

This survey aims to evaluate the long-term impacts of the environmental education that was done in survey 3 (March 2 to 18, 2015). Survey 4 measured the knowledge level of the 5th grade students in group 1 two months after the day when environmental education was done. Survey 4 involved students from school 3 and was done to evaluate the difference between students who took the environmental education and those who did not.

My Feeling about Environmental Education Activities

	YES	SOMETIMES	NO
1. I like to join activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. I want to attend again	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Activities are hard for me	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. I like to do other environmental education activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. I like to attend activities with my friends	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. I like to attend activities with my family	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Activities are boring	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. If you have any idea about activities, write down your ideas below	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
-			
-			
-			
-			
-			

Fig. 5. Activity evaluation sheet.

3. Results and discussion

3.1. Student knowledge and behavior for protecting the environment

Table 5 summarizes the number of total students engaged in the surveys. This study started in February 2014 when group 1 students were 4th graders and continued for 1 year until the students became 5th graders. The 247 group 1 students from Schools 1 and 2 engaged in all four surveys. As group 2 from School 3 was the control, it was determined that 78 students would be a sufficient reference point.

Fig. 6 showed basic knowledge about the environment that we summarized from survey 1. The questions asked for facts about environmental problems and protection methods. For example, we asked “What is an eco-bag?” and “What are the causes of air pollution?” to obtain the first two results in Fig. 6. We provided multiple-choice answers in the questionnaire, and students were asked to choose answers that they thought were correct. Fig. 6 shows the percentage of students who chose the right answers. The students had knowledge in some areas, such as reasons for air pollution (84%), reason for water pollution (71%), and effect of forest degradation (81%). However, the students had limited knowledge about the eco-bag (23%).

Fig. 7 shows student ideas about how they could protect the environment with the results collected from survey 1. This figure was created from student responses to the open question “Please write three activities that you think can protect the environment.” Most students thought that they could protect the environment if they disposed of waste in a dustbin (28%) or planted and took care of trees (40%). In addition, 70% of the students answered that “Not dumping waste” could help protect the environment. Although many students thought that disposing of waste in the right place could help protect the environment, they did not show much care about separating waste before disposal: Just 10% of the students cared about separating waste before throwing it away.

3.2. The effect of environmental education by the authors

Fig. 8 shows the change in student knowledge during the one-year survey. This study used same questions to evaluate students' knowledge. Students answered questions about the eco-bag, plastic bags, food waste collection systems, and food waste treatment systems in survey 2 (May 2014), survey 3 (March 2015), and survey 4 (May 2015). Among the 247 students at the two elementary schools in survey 2, only 29% of the students said that they knew “what is an eco-bag,” and 55% of students knew that “plastic bags are difficult to decompose naturally.” The question of “food waste collection systems” required the students to recognize a woman doing a job as shown in the picture in Fig. 9. Among the students, 82% correctly identified her job. The result of “food waste treatment systems” counted the number of answers that chose “Recycling for raising pigs” in the following question.

Question: Which do you think best to treat food waste? You can choose many answers.

- Recycling for producing fertilizer
- Recycling for raising pigs

Table 5
Number of students participating in the survey.

Survey	School 1 (Ong Ich Khiem)	School 2 (Dung Si Thanh Khe)	School 3 (Le Dinh Ly)
1	189	183	—
2	180	170	—
3	168	141	—
4	165	135	78

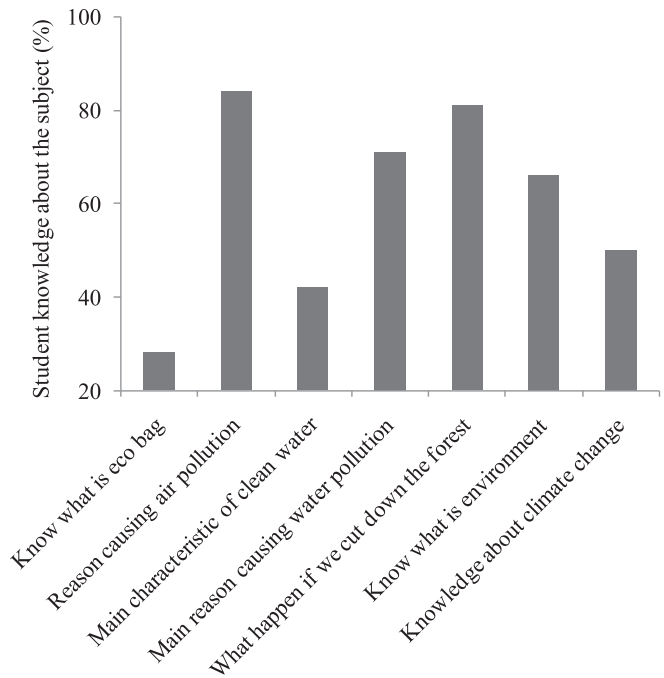


Fig. 6. Basic knowledge of the students about the environment (survey 1).

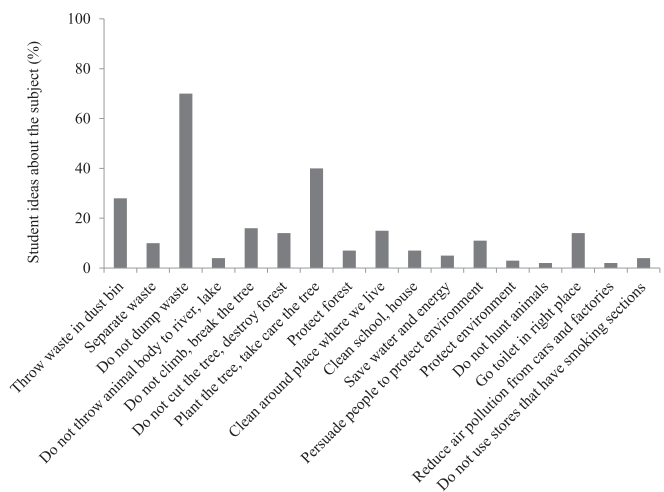


Fig. 7. Student ideas of how they can protect the environment (survey 1).

- Using for producing energy (gas, electricity)
- Dump in the landfill site

After environmental education as reflected in survey 3 (March 2015), students' knowledge increased, such as eco-bags (87%), plastic bags (71%), food waste collection systems (93%), and food waste treatment systems (96%). In survey 4, students' knowledge levels slightly decreased after two months of environmental education, but the knowledge levels remained higher than the ones recorded before the education. Table 6 shows t-test results between

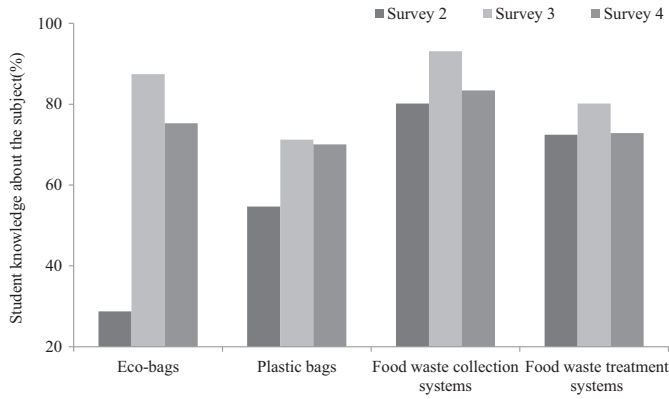


Fig. 8. Changes in student knowledge during one year of the survey.

survey 2, survey 3, and survey 4. A paired t-test was conducted to compare (the student knowledge) about eco-bag and plastic bag in (survey 2) before environmental education and (survey 3) after environmental education for the same students in schools 1 and 2. There was a significant difference in the scores for the plastic bag between survey 2 and survey 3; $t(246) = -3.934, p = 0.000$. There was not a significant difference in the scores for plastic bag between survey 3 and survey 4; $t(246) = 0.350, p = 0.726$.

The study found a significant difference between school 1, located in the center of Da Nang city, and school 2, located in a distance from the center, about knowledge of food waste collection and treatment systems as shown in Fig. 10. After environmental education at survey 3, 92% of the students from school 1 and 99% of the students from school 2 correctly identified the role of food waste collector shown in Fig. 9. We interpreted this result that because school 2 was located near a rural area the students were often exposed to a food waste collection system. On the other hand, school 1 is located in the center of the city where food waste collection is not practiced frequently; therefore, the students would not have much exposure to such a system. The study used chi-square test to check for significant differences between the two treatment groups and genders in survey 3. The study did not find any significant difference between the game and without game groups or between genders in survey 3 about eco-bags, plastic bags, food waste collection systems, or food waste treatment systems.

Fig. 11 shows the students' knowledge about solid waste management after environmental education in school. We used the results from three questions about organic waste, inorganic waste, and recyclable or reusable waste. This is the content in

Table 6
T-test result of Fig. 8

Knowledge	Comparison	T-test
Eco-bag	Surveys 2 and 3	$t(246) = -17.564, P = 0.000$
	Surveys 4 and 3	$t(246) = 3.569, P = 0.000$
Plastic bag	Surveys 2 and 3	$t(246) = -3.934, P = 0.000$
	Surveys 4 and 3	$t(246) = 0.350, P = 0.726$
Food waste collection system	Surveys 2 and 3	$t(246) = -4.435, P = 0.000$
	Surveys 4 and 3	$t(246) = 4.128, P = 0.000$
Food waste treatment system	Surveys 2 and 3	$t(246) = -2.100, P = 0.037$
	Surveys 4 and 3	$t(246) = 2.137, P = 0.034$

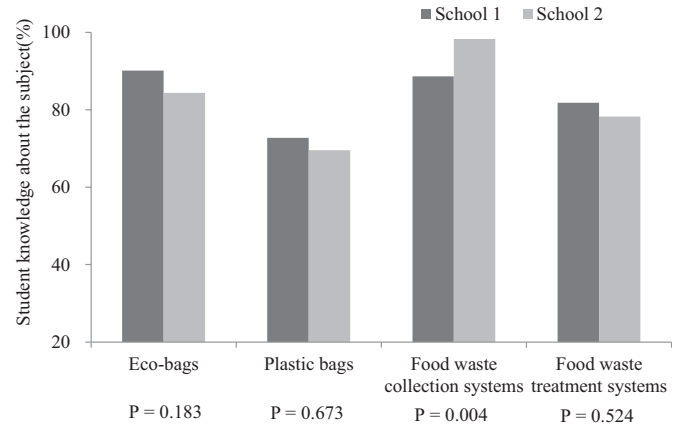


Fig. 10. Student knowledge in different schools (survey 3).

environmental education in survey 3 (March 2015). Checked options are those assumed by the authors to be the correct answers. The figure shows the proportion of correct answers obtained from the students.

- Which is the best answer to describe organic waste?
 - Flower, fruit, tea waste, food waste, leaves, vegetables, and coffee waste
 - Fruit, tea waste, food waste, leaves, vegetables, and coffee waste
 - Flowers, fruit, leaves, vegetables, and coffee waste
 - I do not know.
- Which is the best answer to describe inorganic waste?
 - Plastic bags, bones, waste from toys, tissue paper, old clothes, tree brands, seashells, coal, and glass

Question: Please see picture below and answer the question.



- Do you know what the woman is carrying?
- Food waste collection from households and restaurants
 - Water
 - I don't know
 - Other answer.....

Fig. 9. Question about food waste collection systems.

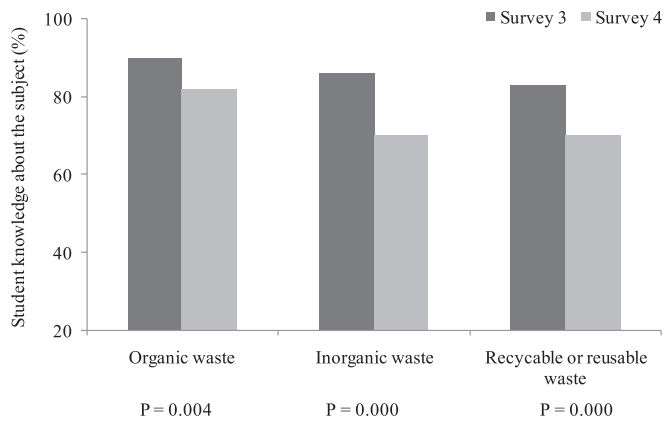


Fig. 11. Student knowledge about solid waste management after environmental education.

- Plastic bags, tissue paper, old clothes, tree brands, seashells, coal, and glass
 - Plastic bags, bones, waste from toys, tree brand, seashells, coal, and glass
 - I do not know.
3. Which is the best answer to describe recyclable or reusable waste?
- Cans, bottles, recycle bags, and newspapers
 - Cans, bottles, and newspapers
 - Cans, recycle bags, and newspapers
 - I do not know.

These waste categories referred to the ones used in the 3Rs project in Ha Noi city [30]. Since this research considered recycling of food waste for feeding local pigs, the category of organic waste in this study excluded some items from Ha Noi's, such as eggshells, and animal carcasses.

Many students correctly answered the questions after our environmental education: organic waste, 90%; inorganic waste, 86%; and recyclable or reusable waste, 83%. Two months later, the proportion of correct answers declined and became 82% for organic waste, 70% for inorganic waste, and 70% for recyclable or reusable waste. The study found that the student knowledge about solid waste management decreased 2 months after the environmental education. This is a natural consequence of one time education because repeated retrieval of learned information is the key to long-term retention of that information [33].

The correct answer was always the first alternative among these questions. The literature on questionnaire surveys has investigated the effects of the order of placing alternatives, but there is no clear agreement among researchers on such effects. For example, Foddy expects the first alternative should be chosen more than others (the primacy effect) in surveys using a written questionnaire [34]. However, other studies predict no significant response-order effects when a written questionnaire is used, since respondents can easily reevaluate the alternatives ([35], among others). Our study could not determine the impact of the response order effect to the answers by our subjects. Elimination of possible biases due to our questionnaire design is a topic for our future research.

Fig. 12 shows the difference in students' knowledge about solid waste management among classes after environmental education in school 1. The chi-square test found significant statistical differences between the four classes in school 1. The study found two possible reasons for this difference. The first one is that in classes 5.1 and 5.3 of school 1, a foreign researcher was present in the class. His presence could have a positive impact on students when they

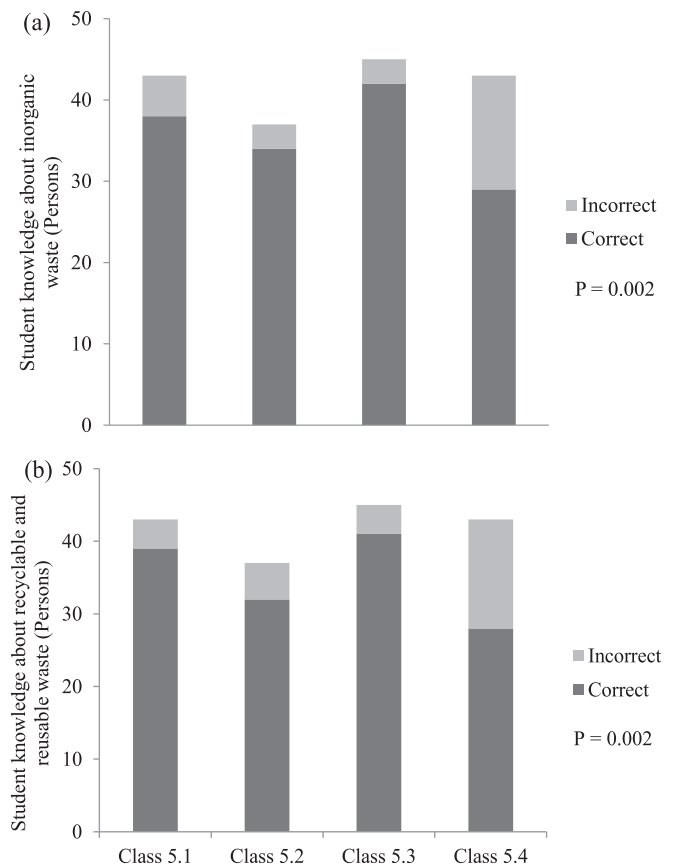


Fig. 12. Student knowledge in school 1 (survey 3).

attended environmental education activities. The other reason may be due to the order effect of education that class 5.4 in school 1 was the first class where environmental education was introduced. The student in classes 5.1, 5.2 and 5.3 could obtain information from their friends in class 5.4 that had already finished our environmental education. Therefore, they might have prior knowledge of contents of the environmental education. There was no difference among the four classes in school 2. We think this is because many students knew about the food waste collection systems. They were, thus, interested in the environmental education and free from the order effect shown in school 1.

Figs. 13 and 14 show the results from our activity evaluation sheet for students who attended the environmental education. Based on the results of this checklist we understand the student behavior when they participate in the environmental education. In the activity evaluation sheet, the study seeks to assess the students' intention to attend the environmental education with a friend and family. This is because our future activity may involve parents in student activities. Fig. 13 shows responses of students in the two environmental education treatment groups. The chi-square test did not find significant statistical differences between treatment group 1 (with a game) and treatment group 2 (without a game). Thus, the results were pooled together between the two groups. Of all the students, 89% said that they wanted to attend the activities again, 67% wanted to attend the activities with their friends, and 85% wanted to attend the activities with their family.

The study found a significant difference between the students in the two schools when they participated in environmental education as shown in Fig. 14. The students from school 2 seem more interested in activities than the students from school 1. Students in school 2 had more opportunities to observe aspects of the food

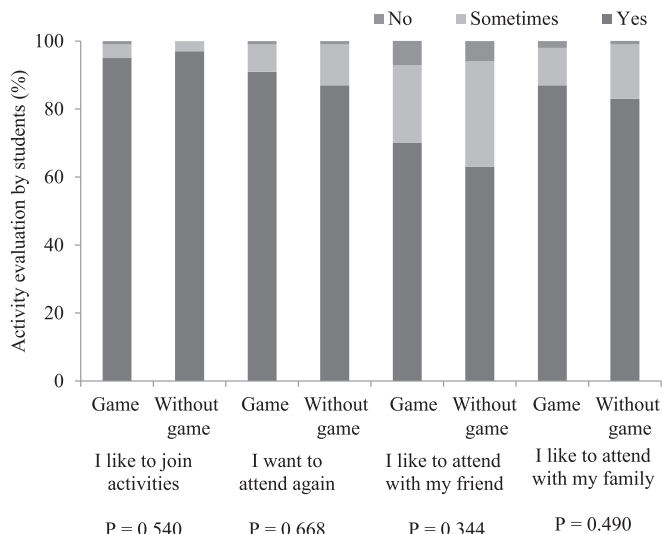


Fig. 13. Activity evaluation by students (survey 3).

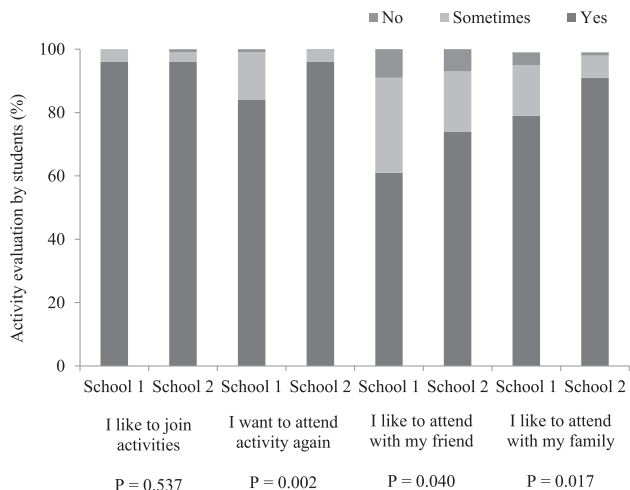


Fig. 14. Activity evaluation by students from school 1 and school 2 (survey 3).

waste collection system that influenced their responses in environmental education. It is expected that the society, family, and school would impact students' knowledge and behavior. In this case, practices observed in society have a positive impact on students who participate in environmental education.

Fig. 15 compared knowledge levels about solid waste management between the students who joined our environmental education (schools 1 and 2) and those who did not (school 3). Our environmental education successfully increased student knowledge.

4. Conclusions

This study has discussed the present situation of students' environmental knowledge and a detailed description of environmental education for elementary students in Da Nang city, Vietnam, with special emphasis on solid waste management. Our results show that elementary students in Vietnam have basic knowledge about water pollution, air pollution, typhoon protection, natural energy, saving of energy, natural resources, soil pollution, and saving and protecting water (the study selected keywords from elementary textbooks). Of the students, 84% knew

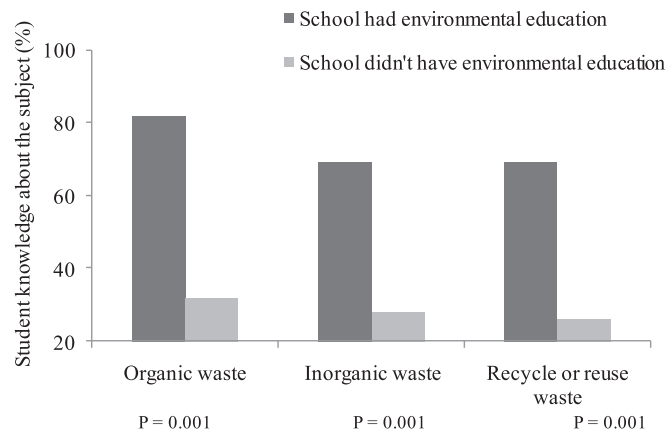


Fig. 15. Comparison about student knowledge between the groups (survey 4).

reasons causing air pollution, 71% knew reasons for water pollution, and 81% of the students could answer the question of what will happen if we cut down the forest. However, their knowledge about solid waste management was limited. For example, only 23% of students knew about the eco-bag.

From the results, environmental education increased environmental knowledge in elementary schools. It was found that after environmental education the students were adept with the concepts of organic waste, inorganic waste, and recyclable and reusable waste. The students' interest in the environmental education in school was that 96% liked the educational activities, and 89% wanted to attend the activities again. In order to reduce pollution from solid waste, this study's environmental education with regard to waste separation, eco-bags, and food waste collection systems will help create a more comprehensive curriculum.

The study reveals certain strategic constraints of the environmental education done by the authors. This environmental education was done just once, and the grades obtained were not counted in the students' scores. For this reason, the activities might not be taken as seriously and may not actually change students' behavior. Since Da Nang city does not have an official source separation policy of MSW, it is not possible to observe behavioral change in the students.

We believe that environmental education at elementary schools is an effective approach to raising awareness of sustainability issues among people in Southeast Asian countries. This is because the number of out-of-school children of secondary- and higher-education age increases relative to those in primary education. In Vietnam, between 2012 and 2013, 98.3% of the children went to elementary schools. Among them, 92.3% entered middle schools [36]. In Thailand, Indonesia, and Cambodia, 96, 94, and 86% of children went to elementary schools, respectively [37]. The rates of continuation to secondary schools among these countries were 95, 96, and 80%, respectively [37]. Therefore, by focusing on environmental education in elementary schools, we can reach most of the children.

For future research, efficient methods for increasing student knowledge about the environment, in particular about solid waste management, will be investigated. According to the results from this research, we plan to organize environmental education in 3-months for 5th grade elementary students. The environmental education may consist of in- and out-of-class activities regarding solid waste education. We will try to make the environmental education become the extracurricular activities for elementary students in school. We expect a change in students' behavior to impact the students' parents.

Acknowledgement

This work was supported by KAKENHI Grant Number 25303006 from the Japan Society for the Promotion of Science.

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