EnvironmentAsia
The international journal by the Thai Society of Higher Education Institutes on Environment

EnvironmentAsia 11(2) (2018) 118-127
DOI XXXXXXXXXXXXXXXXXXXXX
ISSN 1906-1714; ONLINE ISSN: 2586-8861

Evaluation of a Locally-developed Zero Waste Management Curriculum for Primary School Pupils in KhonKaen Municipality Schools, KhonKaen Province, Thailand

Thinadda Pimpuang, and Pattapong Kessomboon*

Department of Community Medicine, Faculty of Medicine,
KhonKaen University, Thailand

*Corresponding author: pattapng@kku.ac.th
Received: January 21, 2018; March 11, 2018

Abstract

Waste management is a major challenge for many communities across Thailand. A centrally-developed solid waste management curriculum, to promote behavior change among children and adolescents, has limitations due to difficulties of generalizability. In this study a locally-developed zero waste management curriculum was applied using the Delphi Technique, in-depth interviews and participatory meetings. This curriculum, consisting of ten 50-minute learning modules, was implemented in a group of 205 pupils (Grades 4 - 6 primary school), whereas a control group of 223 pupils received only a conventional solid waste management curriculum. Pupils learning outcomes were assessed at the end of each session, and on the last day of the course, using standardized tests and questionnaires. A test of the differences showed that the scores of learning outcomes among the Experimental Treatment Group, in terms of the Cognitive Domain, the Affective Domain and the Psychomotor Domain, had increased 24.6%, 22.6 % and 32.6%, respectively, from the Control Group; the differences being statistically significant (p-value <0.001). Additionally, pupils' behavior in conducting 'Solid Waste Management with the 3Rs + Disposal' (namely the reduction, reuse, recycling and appropriate disposal of solid waste) showed increased differences that were statistically significant (p-value < 0.01). The locally-developed Zero Waste Management curriculum was effective in terms of improving pupils' knowledge, understanding, awareness, skills and behaviors in solid waste management.

Keywords: Cognitive; Affective; Psychomotor; Zero waste management; Curriculum

1. Introduction

Current global statistics estimate that each person generates an average of 1.2 kg of solid waste/day, or 1.3 billion tonnes/year (World Bank, 2012). That is predicted to increase up to 1.4 kg/person/day by 2025, or 2.2 billion tonnes/year (World Bank, 2012). Solid waste (including plastics), discarded into various water sources, ends up in the sea, and so accumulates in oceans around the globe (TTF International, 2015).

Studies have shown that solid waste landfills constitute environmental problems and health risks to people living within a radius of two kilometers. Babies born to women exposed to landfill toxic waste are affected by low birth weight and congenital malformations. People, particularly children, living closer to the landfills experience higher risk of cancer (WHO, 2007; Porta, 2009; Sever, 1997; Johnson,1999). Combustion in incinerators is a known risk factor for Non-Hodgkin's Lymphoma and Soft Tissue Sarcoma (Viel *et al.* 2000). People living within a distance of three kilometers stand a 3.5% risk of contracting cancer (Viel *et al.,* 2008). The combustion of dioxins at such sites can cause a higher risk of cancer, the Soft Tissue Sarcoma risk being 3.3 times higher than sites where no such combustion takes place (Zambon *et al.,* 2007). Those living near landfills, incinerators, fertilizer factories and nuclear installations stand a high risk of gastrointestinal problems, particularly from waste-water treatment plants (Giusti, 2009; Schoot *et al.,* 2011).

The reduction of use, the reuse and the recycling of natural resources are among the best practices currently available in the management of solid waste (Field and Field, 2002). Countries that have adopted such measures have been successful in solid waste management; examples being Denmark and Japan (Ministry of Economy and Trade Industry, 2014). Many countries pay attention to educating younger generations on waste management in schools, to promote consciousness of environmental maintenance when those generations reach adulthood (US EPA, 2007). Solid waste management curricula developed in schools have different models, details and focuses, according to the context of their individual locations. Most of these curricula emphasize learning in the classroom and then the application of that learning under real conditions (Mesa County, 2014; Cornell University, 2014; Enrico, 2014).

In Thailand, the amount of solid waste generated has long been on the rise, with increasing challenges for waste management. The quantity of solid waste produced from 2008 - 2013 was 1.15 kg/person/day, or 26.8 million tonnes/year (Pollution Control Department, 2014). Thailand has already given priority to the management of solid waste in schools by using strategies for solid waste reduction, separation and recycling. The Thai Ministry of Education has developed a core curriculum, and defined the learning standards and performance indicators in this field. (Ministry of Education, 2008). There are several ongoing school projects, involving recycling banks and zero waste management schemes. A network of schools has been established to pilot a solid waste management curriculum. That network has created learning systems through the use of various theoretical and practical activities, and encouraged the participation of pupils to cultivate the desired habit of environmental responsibility. (Ministry of Education, 2015; Ministry of Natural Resources and Environ-

ment, 2014; Pradabphetrat *et al.,* 2013; Siladet, 2014). However, a report from the Office of the Education Council (2009), found that one factor affecting education quality in Thailand was that of curriculum development needing to be appropriate to the context of different areas of the country. The report concluded that modifications to education policy should involve a contributory role for local schools, to assist in developing curricula that are appropriate to the context and needs of different local communities. It is thought that all parties should be involved to work together in a systematic and continuous manner to plan, execute, support, and monitor the new curriculum (Ministry of Education, 2008).

KhonKaen is one of the Thai provinces with surging solid waste management challenges. In 2013, the rate of solid waste generated was 0.62 kg/person/day or 206 tonnes/day, or 75,000 tonnes/year (Regional Environmental Office 10 KhonKaen, 2014). Although KhonKaen Municipality has initiated a low carbon and zero waste city project, the implementation is far from meeting its original targets. (Department of Public Health and Environment, KhonKaen, 2014). Within this context, this quasi-experimental research aimed to study the effectiveness of a locally-developed zero waste management curriculum on pupils' learning.

2. Materials and Methods

This is a quasi-experimental study. Participants were Grade 4-6 primary school pupils in KhonKaen Municipality. They were divided into 2 groups: The Experimental Group of 205 pupils and the Control Group of 223 in a different school. The Experimental Group received the Zero Waste Management curriculum, whereas the Control Group received a conventional school curriculum on solid waste management. The Zero Waste Management curriculum was developed by a group of school teachers, administrators, school environmental operatives and pupil leaders. The intervention consisted of 10 learning units. i.e. Unit 1: The importance and problems of solid waste management, Unit 2: Types of solid waste, Unit 3: Technology and solid waste management, Unit 4: Waste management principles with the 3Rs + Disposal, Unit 5: Environmental discipline and consciousness, Unit 6: Solid waste separation, Unit 7: The design of separation containers at home, Unit 8: Activities for pupils to learn tree species, Unit 9: Trees are Life; and Unit 10: Organic waste decay into enzyme ionic plasma. Data collection involved measurement before and after the curricula were put into operation, using questionnaires. These questionnaires were divided into 4 parts. i.e. Part 1: General information about personal and family status, Part 2: A 30-item, 4-option multiple choice questionnaire to test pupils' understanding of solid waste management (cognitive data), Part 3: An 18-item Likert Rating Scale to measure pupils' psychological behavior, values, feelings, attitudes, and beliefs about solid waste management (affective data), and Part 4: A 21-item Ranking Order questionnaire to measure solid waste management behavior in the reduction, reuse, recycling and disposal of solid waste (psychomotor data).

This questionnaire had been tested for validity by 5 experts. The Item Content Validity Index (I-CVI) was more than 0.80 and the Content Validity for Scale (S-CVI) was 0.96. A pilot test was conducted with 30 pupils to analyze the reliability of the questionnaire. It was found that the overall reliability was greater than 0.70, with 0.741 for Cognitive Domain items, 0.763 for Affective Domain items and 0.840 for Psychomotor Domain items. The Difficulty Index of the Cognitive Domain items was from 0.2 - 0.8.

3. Results and Discussion

3.1 General Information

Most of the subjects were female at 61%, with males at 39%. The pupils in the Experimental Group were in Grades 4, 5 and 6 - in percentage terms, 35.1%, 37.6% and 27.3%, respectively; whereas the Control Group in the same grades were 35.6%, 33.6% and 32.7%, respectively. The education level of parents of the Experimental Group and the Control Group was mostly primary school at 56.6% and 46.2%, respectively. The two groups were similar in these respects (p-value > 0.05). (Table 1)

Table 1: General information by numbers of subjects (and their percentage in each group) in the Experimental and Control Groups

Item	Intervention Group (n = 205)	Control Group (n = 223)	Total (n = 428)	*P*-value
Sex				$p>0.05$
Male	88 (42.9)	79 (35.4)	167 (39.0)	
Female	117 (57.1)	144 (64.6)	261 (61.0)	
Education Level				$p>0.05$
Grade 4	72 (35.1)	75 (35.6)	147 (34.3)	
Grade 5	77 (37.6)	75 (33.6)	152 (35.5)	
Grade 6	56 (27.3)	73 (32.7)	129 (30.1)	
Education Level of Parents				$p>0.05$
No school education	6 (2.9)	2 (0.9)	8 (1.9)	
Primary school	116 (56.6)	103 (46.2)	219 (51.2)	
High school	43 (21.0)	81 (36.3)	124 (29.0)	
Bachelor's degree	13 (6.3)	16 (7.2)	29 (6.8)	
Above bachelor's degree	2 (1.0)	6 (2.7)	8 (28.0)	
Don't know	24 (11.7)	14 (6.3)	38 (8.9)	
Occupation of Parents				$p>0.05$
Contractor	80 (39.0)	85 (38.1)	165 (38.6)	
Trader	87 (42.4)	101 (45.3)	188 (43.9)	
Agriculturalist	6 (2.9)	15 (6.7)	21 (4.9)	
Government official	21 (10.2)	11 (4.9)	32 (7.5)	
Private businessperson	5 (2.1)	5 (2.2)	8 (1.9)	

3.2 Results of Cognitive Domain, Affective Domain and Psychomotor Domain behaviors, before and after intervention

With Cognitive Domain behaviors in the Experimental Group, before receiving the Zero Waste Management curriculum the mean was 11.98 (SD = 5.74), and after receiving that curriculum the mean was 19.36 (SD = 6.59); a percentage increase of 24.6%. With Affective Domain behaviors 'before', the mean was 62.65 (SD = 9.35), and 'after', the mean was 69.43 (SD = 8.89); a percentage increase of 22.6%. With Psychomotor Domain behaviors 'before', the mean was 20.17 (SD = 8.91), and 'after', the mean was 29.96 (SD = 8.10); a percentage increase of 32.6%.

With Cognitive Domain behaviors in the Control Group, before receiving the conventional solid waste management curriculum, the mean was 10.83 (SD = 4.60), and after receiving that curriculum, the mean was 11.80 (SD = 4. 96); a percentage increase of 3.2%. With Affective Domain behaviors 'before', the mean was 62.90 (SD = 8.40), and 'after', the mean was 63.33 (SD = 8.90); a percentage increase of 1.4%. With Psychomotor Domain behaviors 'before', the mean was 20.36 (SD = 9.6), and 'after', the mean was 20.73 (SD = 9.40); a percentage increase of 1.2%.

A test of the differences between the Experimental Group and the Control Group found that the means of both groups 'before' were not significantly different ($p > 0.05$). After receiving their respective curricula, the difference in means between the Experimental Group and the Control Group was significantly different ($p < 0.05$), with the Experimental Group having higher mean scores than 'before' in all three domains. (Table 2)

Table 2: Mean scores of Solid Waste Management behavior in the Cognitive, Affective and Psychomotor domains

Domain & Timing		Experimental Group (n=205)			Control Group (n=223)			Difference between groups	P-value
		Mean	SD	Difference within group	Mean	SD	Difference within group		
Cognitive	Before	11.98	5.74	7.38	10.83	4.60	0.97	1.15	0.085
	After	19.36	6.59		11.80	4.96		7.56	<0.001
Affective	Before	62.65	9.35	6.78	62.90	8.40	0.43	0.25	0.813
	After	69.43	8.89		63.33	8.90		6.1	<0.001
Psychomotor	Before	20.17	8.91	9.79	20.36	9.60	0.37	0.19	0.572
	After	29.96	8.10		20.73	9.40		9.23	<0.001

3.3 *Comparison of items of Solid Waste Management behavior with the 3Rs + Disposal*

Comparison of Solid Waste Management behavior with the 3Rs + Disposal (namely the reduction, reuse, recycling and appropriate disposal of solid waste), found that the mean of the 'reduction' behavior in the Experimental Group was 5.25 (SD = 1.90), while in the Control Group it was 4.68 (SD = 1.98); this being significantly different, statistically (p = 0.002). The mean of the 'reuse' behavior in the Experimental Group was 4.25 (SD = 1.62), while in the Control Group it was 3.43 (SD = 1.69); this being significantly different, statistically (p< 0.001). The mean of the 'recycling' behavior in the Experimental Group was 5.27 (SD = 2.07), while in the Control Group it was 4.24 (SD = 2.02); this being significantly different, statistically (p< 0.001). The mean of the 'disposal' behavior in the Experimental Group was 12.32 (SD = 3.61), while in the Control Group it was 10.96 (SD = 4.24); this being significantly different, statistically (p< 0.001). (Table 3)

The results of this experiment showed that the learning behavior of pupils in the Experimental Group had higher mean scores than the Control Group, and these higher scores were statistically significant in terms of knowledge, attitudes and practices. This was possibly because their curriculum included learning activities with both theory and practice. That curriculum included a variety of media, such as cartoon books and videos, and also included learning about the real practice of solid waste segregation and enzyme ionic plasma production; with an additional Clean Home contest. Classifying bins were installed in every classroom used with this curriculum. After pupils' normal day-to-day generation of solid waste, they could separate their own garbage and place it in the appropriate garbage classification bins. All of the curriculum activities were designed to be important in promoting and supporting the pupils' awareness and practice of solid waste management.

Table 3: Comparison of Solid Waste Management behavior with the 3Rs + Disposal, before and after intervention

		Experimental Group (n= 205)			Control Group (n= 223)				
Waste management behavior	**Timing**	**Mean**	**SD**	**Difference within group**	**Mean**	**SD**	**Difference within group**	**Difference between groups**	***p*-value**
Reduction	Before	3.89	2.03	1.36	3.97	2.2	0.71	0.08	p>0.05
	After	5.25	1.90		4.68	1.98		0.57	p = 0.002
Reuse	Before	3.04	1.81	1.21	2.95	1.89	0.48	0.09	p>0.05
	After	4.25	1.62		3.43	1.69		0.82	p<0.001
Recycling	Before	3.78	1.89	1.49	3.95	1.2	0.29	0.17	p>0.05
	After	5.27	2.07		4.24	2.02		1.03	p<0.001
Appropriate disposal	Before	9.52	4.02	2.80	9.98	4.73	0.98	0.46	p>0.05
	After	12.32	3.61		10.96	4.24		1.36	p<0.001

Other studies have also pointed to the importance of essential knowledge in solid waste management. Relevant knowledge leads to the creation of awareness, behavioral change, and collaboration in recycling activities at schools, as well as in communities. These eventually encourage the formation of desirable habits of solid waste management, so that clean places and a healthy environment can be achieved (Babaei *et al.,* 2015; Gamba and Oskamp, 1994; Hornik *et al.,* 1995; Sekito *et al.,* 2013; Evison and Read, 2001; Bradley *et al.,* 1999; Zsóka *et al.,* 2013)

In addition, raising awareness of the importance of garbage sorting was very essential for changing the behavior of the target group. The 'Solid Waste Management with the 3Rs + Disposal' curriculum achieved this, as demonstrated by the increased Affective Domain score of the Experimental Group. This group's curriculum had a variety of activities to stimulate awareness of the problem of waste overflow. Other studies have identified various factors influencing attitudes of the target group on appropriate solid waste management: namely the convenience, the influence of society and the opportunity to practice appropriate techniques for solid waste management. (Milea, 2009; O'Connell, 2011; Babaei *et al.,* 2015; Refsgaard and Magnussen, 2009)

One of the learning activities of this curriculum was putting classifying bins in the classrooms, hallways, and cafeterias, with separation points for food & drink residues to simplify that process. Grodzińska-Jurczak (2003) also found that if the recycling bins were available, then most people (75%) would recycle accordingly.

This curriculum was designed to holistically educate the target group with the knowledge, the attitudes and the practice dimensions of solid waste management, so that the desired behaviors could occur.

The Zero Waste Management curriculum was developed and agreed upon by participants from all stakeholder groups, to ensure that ownership was built. All parties were willing to cooperate and provide support resources. School leaders announced zero waste school policies. Teachers and pupil leaders helped design the courses. Parents supported and encouraged pupils to separate solid waste at home. Local government officials provided support resources and provided prizes for the Clean Home Contest.

There were some challenges in repeating the success of this project in other schools. For instance, curriculum coordinators (CCs) should recognize the possible limitations of different learning levels in pupils. CCs should also be able to coordinate with many different stakeholder agencies, and they should be flexible in their approach when the course is implemented to lower level classes than Grade 6 - as pupils in such lower class grades might experience some difficulties with the curriculum content. CCs should also choose an appropriate time of year according to the seasonal weather situation, as well as considering how the course might interfere with the extra-curricular activities of the school. Successful schools should be promoted as role models. Teachers should be encouraged to learn from the experience of other schools that have already used the curriculum, with regard to both their successes and failures. Teachers should be invited to participate in the development of solid

waste management curricula that are appropriate for their own locations. Future attempts should be made to form research networks to initiate new models of solid waste management curricula for schools, and thus ensure that successive generations are well prepared to help create a sustainable world.

4. Conclusions

The Zero Waste Management curriculum achieved its objectives in increasing pupils' learning of solid waste management skills, in terms of cognitive, affective and psychomotor behaviors. The Experimental Group's learning scores were significantly higher than those of the Control Group. A participatory approach to curriculum development among major stakeholders was a key factor in ensuring success.

Acknowledgements

This work was carried out with funding sources from the Prince of Songkhla University (PSU), Thailand.

References

Babaei A A, Alavi N, Goudarzi G, Teymouri P, Ahmadi K, Rafiee M. Household recycling knowledge, attitudes and practices towards solid waste management. Resources, Conservation and Recycling 2015; 102: 94-100.

Bradley J C, Waliczek T M, Zajicek J M. Relationship between environmental knowledge and environmental attitude of high school students. The Journal of Environmental Education; Madison 1999; 30(3): 17-21.

Cornell University. The Cornell Waste Management. 2014; Available from: http://cwmi.css.cornell.edu/.

Department of Public Health and Environment in Khon Kaen Municipality. low carbon city project operating summary report. Khon Kaen. Thailand. 2014.

Enrico U B. A research on school-based solid waste management. 2014; Available from: http://yesocagayanvalley.wordpress.com/2012/08/25/a-research-on-school-based-solid-waste-management.

Evison T, Read A D. Local authority recycling and waste- awareness publicity/promotion. Resources, Conservation and Recycling 2001; 32(3-4): 275-291.

Field B C, & Field M K. Environmental economics: An introduction; New York McGraw-Hill Higher Education, New York, USA. 2002.

Gamba R J, Oskamp S. Factors influencing community residents' participation in commingled curbside recycling programs. Environment and Behavior 1994; 26(5): 587-612.

Giusti L. A review of waste management practices and their impact on human health. Journal of Waste Management 2009; 29(8): 2227-2239.

Grodzińska-Jurczak M. The relation between education, knowledge and action for better waste management in Poland. Waste Management & Research 2003; 21(1), 2-18.

Hornik J, Cherian J, Madansky M, Narayana C. Determinants of recycling behavior: A synthesis of research results. The Journal of Socio-Economics 1995; 24(1), 105-127.

Johnson B L. A review of the effects of hazardous waste on reproductive health. American Journal of Obstetrics and Gynecology 1999; 181(1): S12-S16.

Meneses G D, Palacio A B. Recycling Behavior: A Multidimensional Approach. Environment and Behavior 2005; 37(6): 837-860.

Mesa County. Solid Waste Management Curriculum. 2014; Available from: http://www.mesacounty.us/swm/education/cirriculum.aspx.

Milea A. Waste as a Social Dilemma. Municipal Solid Waste Management. Delhi, India. 2009.

Ministry of Economy Trade and industry. Trade and Industry. Law for promotion of sorted collection and recycling of containers and packaging. 2014; Available from: http://www.meti.go.th/english/information/downloadfiles/cReCont02e.pdf.

Ministry of Natural Resources and Environment. Zero Waste School Contest. 2014; Available from: http://uttaradit.mnre.go.th/ewt_news.php?nid=93.

Ministry of Education. The basic education curriculum: ensuring to education reform of Thailand. 2015; Available from: http://www.moe.go.th/moe/th/cms_group/detail.php? NewsID=136&.Key = aca_article.

Ministry of Education. The basic education core curriculum 2008; Bangkok: Teachers Council, Ladprao. 2008.

O'Connell EJ. Increasing public participation in municipal solid waste reduction. Geographical Bulletin 2011; 52(2): 105-118.

Office of the Education Council. The report synthesis the research study in Thailand: (Meta analysis). Bangkok, Thailand. 2009. recycling behavior. Environment and Behavior 1991; 23(4), 494-519.

Pradabphetra P, Nawagawong S, Aroonsrimorakot S, Tantrakarnapa K. Potential of community waste reduction under the recycle waste bank project. Journal of environmental management2013; 6(2): 54-66.

Pollution Control Department. Thailand's pollution situation in 2013. 2014; Available from: http://www.pcd.go.th/public/Ne ws/GetNewsThai.cfm?task=lt20 14&id=17119.

Porta D, Milani S, Lazzarino AI, Perucci CA, Forastiere F. Systematic review of epidemiological studies on health effects associated with management of solid waste. Journal of Environmental Health: A Global Access Science Source 2009; 8: 60.

Regional Environmental Office 10 Khon Kaen. The management problem of Khon Kaen province. 2014; Available from: http//www. banmuang.co.th//10/2014, Khon Kaen, a champion of waste residues.

Refsgaard K, Magnussen K. Household behaviour and attitudes with respect to recycling food waste – experiences from focus groups. Journal of Environmental Management 2009; 90(2): 760-771.

Schoot Uiterkamp BJ, Azadi H, Ho P. Sustainable recycling model: A comparative analysis between India and Tanzania. Journal of Resources, Conservation and Recycling 2011; 55(3): 344-355.

Sekito T, Prayogo TB, Dote Y, Yoshitake T, Bagus I. Influence of a community-based waste management system on people's behavior and waste reduction. Resources, Conservation and Recycling 2013; 72: 84-90.

Sever LE. Environmental contamination and health effects: what is the evidence. Toxicology & Industrial Health 1997; 13 (2- 3): 145-161.

Siladet C, Advantages of basic education core curriculum. 2014; Available from: http://www.gotoknow.org/posts/2984.

TTF International. Waste management concepts "zero waste or waste to zero". 2014; Available from: http://www.energysavingmedia.com/news/page.php?a=10& n=109&cno=3007

US EPA O, EPA U. Waste Management. 2014; Available from: http://www.epa.gov/osw/education/teachers.htm.

Viel JF, Arveux P, Baverel J, Cahn JY. Soft-tissue sarcoma and Non-Hodgkin's lymphoma clusters around a municipal solid waste incinerator with high dioxin emission levels. American Journal of Epidemiology 2000; 152: 13-19.

Viel JF, Daniau C, Goria S, Fabre P, De Crouy Chanel P, Sauleau EA, Empereur-Bissonnet P. Risk of Hodgkin's lymphoma in the vicinity of French municipal solid waste incinerators. Journal of Environmental Health 2008; 7 (29): 51.

World Bank. Urban development-what a waste: A global review of solid waste management. 2014; Available from: http://web.worldbank.org/wbsite/external/topics/exurban development/0, contentmdk:23172887~pagepk:210058~pipk:210062~thesitepk: 337178, 00.html

WHO. Population health and waste management: scientific data and policy options. Report of a WHO workshop, Rome, Italy, 29-30 March 2007. World Health Organization (WHO), European Centre for Environment and Health. 2007.

Zambon P, Ricci P, Bovo E, Casula A, Gattolin M, Fiore AR, Guzzinati S. Sarcoma risk and dioxin emissions from incinerators and industrial plants: a population-based case-control study (Italy). Journal of Environmental Health 2007; 6 (19): 1-10.

Zsóka A, Szerényi ZM, Széchy A, Kocsis T. Greening due to environmental education? Environmental knowledge, attitudes, consumer behavior and everyday pro-environmental activities of Hungarian high school and university students. Journal of Cleaner Production 2013; 48: 126-138.