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RESEARCH ARTICLE

Development of a School-based Intervention Program for Waste Management in a Rural School in Northern Thailand

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Abstract:

Background:

Waste management is a challenging environmental and public health issue in Thailand and throughout the world.

Objective:

This study aimed to develop a school-based intervention program for waste management in one rural school in Northern Thailand.

Methods:

A specific research and development method was employed to develop the school-based intervention program. This consisted of three steps: 1) a problem and need assessment step, wherein 38 key stakeholders associated with the school, including a school administrator, teachers, students, a food vendor, and a janitor, were interviewed to understand the existing waste management problems and intervention components; 2) an intervention development step, involving students, teachers, and researchers who worked together to design an intervention program based on the perspectives of the stakeholders; 3) an intervention implementation and evaluation step, wherein students, teachers, and researchers implemented the developed intervention program in the school and evaluated the appropriateness of the program using an online questionnaire. Qualitative data were analyzed using content analysis, while one-way ANOVA was used to compare waste management knowledge among students at the pre-, right after-, and one-month-after implementation stages.

Results:

The school-based waste management intervention program involved four action plans: 1) empowering peer leadership; 2) supporting peer-led activities; 3) setting up enough bins; and 4) promoting extracurricular activities by peer leaders involving teachers and community leaders. Following the implementation of the program, students demonstrated greater waste management knowledge immediately after the intervention ($p < .05$) and at the one-month follow-up point ($p < .01$).

Conclusion:

This developed school-based intervention program could improve waste management knowledge among adolescents in rural schools.

Keywords: Waste management, School-based intervention, Research and development method, Peer leader, Participation, Thailand.

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1. INTRODUCTION

To date, the amount of solid waste generated annually continues to increase significantly. According to current statistics, the world generates approximately 0.74 kilograms of solid waste per person daily, with an estimated 2.01 billion tons per year [1]. By 2050, global waste generation is expected to grow to 3.40 billion tons since some countries are not manag-

ing their waste in an environmentally safe manner. The East Asia and Pacific region, which includes Thailand, has been recognized as the world's leading waste generator [1]. According to a recent Thai government report, the daily waste generated per capita has averaged 1.03 kilograms, which is higher than the world's average rate. Although the amount of municipal solid waste decreased from 27.37 million tons in 2017 to 24.98 million tons in 2021, the amount of hazardous waste in rural communities, in the way of electronic waste, batteries, chemical containers, and aerosol cans, increased from

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618,749 tons in 2017 to 669,518 tons in 2021 [2]. Moreover, at least 31% of waste generation was improperly disposed of by open burning, uncontrolled dumping, being burnt in incinerators without proper air pollution treatment systems, and by being discharged into waterways [1, 2]. This mismanagement of waste is a crucial issue affecting public health and the environment. This is evident in the form of water, air, soil, and marine pollution and in how waste mismanagement contributes to global warming, the transmission of diseases, and a rise in respiratory problems [1 - 4]. In the northern part of Thailand, there have been significant increases in water and air pollution, respiratory diseases, and dengue fever in the last decade [4]. Thus, effective waste management would be an important and necessary measure in the conservation of the environment and the protection of human health.

Promoting public participation by raising awareness, changing attitudes towards waste management, and providing waste management education among citizens, is a meaningful way to achieve sustainable waste management [1, 4, 5]. However, changing citizen behavior can be a difficult and time-consuming task. Therefore, a school can serve as a strategic place to foster the younger generation's awareness of public health and their understanding of the importance of complying with waste management guidelines and sustainable regulations [5 - 8]. Many studies conducted in developed and developing countries have found that participatory learning is an important approach to waste management education which could help to lead students to participate in waste management practices at their schools [8 - 11]. Therefore, promoting waste management education through participatory learning could raise awareness [1, 10], while improving the attitudes [9] and knowledge of the student body with regard to the importance of proper waste management [8 - 11]. This, in turn, could influence the students' behavior in their daily lives outside of school [8 - 10].

In Thailand, the government has been concerned with the impacts of waste mismanagement on both the environment and the public's health. Thus, the Thai government has engaged in environmental management practices since 2012. Accordingly, the government has recently announced a national agenda for waste management and has proposed policies for pollution control and the effective management of waste. Furthermore, the Thai government has begun to disseminate information to the public pertaining to the three R's approach (reduce, recycle, and reuse) in order to raise awareness among the citizens and to promote public participation in waste management in every sector of society. This requires the involvement of government agencies, manufacturers, community members, hospitals, and non-governmental organizations [2, 3, 12]. In school settings, many previous studies have helped to introduce the concept of waste management education into the curriculum [7, 13, 14] and have promoted extracurricular activities that involve waste management practices [15 - 18]. This has influenced students' attitudes, knowledge, and behavior regarding waste management. However, few studies have emphasized the need to promote student participation regarding these public health concerns [15, 16, 18].

Lamphun is a small province located in the northern part of Thailand. In 2021, waste generated in Lamphun was about 280 tons daily, 92 tons (32.85%) of which were not correctly managed [2]. The three sub-district municipalities with the most solid waste were Pa Sak, Ban Klang, and Sri Bua Ban, accounting for 2.57, 0.78, and 0.47 tons per day, respectively [19]. A pilot survey conducted in four schools in the Sri Bua Ban Sub-district municipality cited open dumping, littering outside bins, non-waste separation, and minimal promotion of waste management awareness and behavior as key contributors to the existing problem. Therefore, this study aimed to develop a waste management intervention program based on student participation in a rural school in Lamphun Province and investigated the appropriateness of the intervention for expanded implementation.

2. MATERIALS AND METHODS

This study employed principles of research and development (R & D) to develop a waste management intervention program in one rural school located in the Sri Bua Ban Sub-district, Lamphun Province, Thailand. Data were collected using qualitative and quantitative methods between the months of May 2019 and December 2020.

2.1. Research Setting

This school is located around 15 kilometers from the city and offers educational opportunities for students from preschool to grade 9. Generally, there were 14 teachers, 24 kindergarten students, and 113 students enrolled in grades 1-9 in this school. Most students' parents were Buddhist and worked to earn a living. In this rural locality, a tight-knit community exists where teachers and neighbors look out for their children. In rural areas, most parents must work and they trust teachers to protect and guide their children in their absence.

2.2. Research Participants

Purposive and snowball sampling techniques were used to recruit the participants as follows:

1) Participants recruited for the problem and need assessment step: 38 participants volunteered to participate in group discussions. These participants were made up of a school administrator, two teachers, a food vendor, a janitor, and 33 students. Inclusion criteria for school staff required participants to be willing to share their experiences in promoting waste management practices in the school. There were three male and two female staff members with a mean age of 38.0 years (S.D. = 13.02). Inclusion criteria for the students required that they be studying in grades 5-8, be willing to share their ideas, and those who had received informed consent from their parents. There were 24 females and nine males in the student group, with an average age of 13.8 years (S.D. = 1.19).

2) Participants recruited for the intervention development step: 19 students in grades 6-8 were recruited as peer leaders. They would be eligible for inclusion if they had any experience of being a leader in any other school health project or had volunteered to participate in developing and implementing waste management activities in their school. There were 15

females and four males in this group, with an average age of 13.2 years (S.D. = 0.98). These students were studying in the eighth grade (n = 7), seventh grade (n = 7), or sixth grade (n = 5).

3) Participants for the intervention implementation and evaluation step: A total of 74 students studying in grades 4-9 were recruited by teachers. There were 41 males and 33 females in this group aged 10-18 years old (mean = 12.9 years, S.D. = 1.83), who agreed to participate in this study (Table 1).

Table 1. Characteristics of students in the intervention implementation step (n =74).

Characteristics	n	%
Sex		
Male	41	55.4
Female	33	44.6
Age		
10-12 years	29	39.2
13-15 years	42	56.7
16-18 years	3	4.1
Education level		
Grade 4	11	14.9
Grade 5	10	13.5
Grade 6	12	16.2
Grade 7	14	18.9
Grade 8	14	18.9
Grade 9	13	17.6

2.3. Developing a School-based Intervention Program for Waste Management

The final goal of this study was to develop a waste management school-based intervention program that would be feasible and practical for teachers and students in a rural school setting. Therefore, this intervention program was developed and pilot tested through three R & D steps that focused on developing and validating a new educational product that could be modified to the specific needs of an actual setting and the relevant needs of stakeholders [20].

2.3.1. Step 1: Problem and Needs Assessment

After receiving approval from the Ethics Committee of the Faculty of Public Health, Chiang Mai University, the researchers contacted the mayor and municipal administration to clarify the waste management issue and establish any relationships necessary for conducting this research study. After receiving formal permission from the mayor of the Sri Bua Ban Sub-district, the researchers contacted the school administrative committees in all four schools to inform them of the research aim and their intent to develop a waste management intervention program in the school. One school was willing to participate in this study. The researchers then engaged with the selected school to investigate the environment and school curriculum; five school staff and 33 students were recruited to join a group discussion through the dissemination of flyers. In total, the researchers conducted one focus group discussion and five group discussions that employed focus group discussion guides to identify the waste management problem, the needs of the stakeholders, and the appropriate intervention components for waste management in that school. After all, the data were analyzed, two group

meetings were held to reflect on the waste management problem and the associated needs of the stakeholders. As a result, the proposed school-based intervention program was comprised of a three-part action plan that included empowering peer leadership, setting up enough bins, and promoting extracurricular activities.

2.3.2. Step 2: Intervention Development

Based on the data obtained from the first step, the researchers worked with teachers to design and identify the process, activities, and equipment for the first action plan, which had been validated by a panel of three experts, one environmental specialist, one community nurse practitioner, and one school health specialist. After that, the researchers revised and implemented the first action plan by training 19 students to be peer leaders and encouraged them to share their ideas and design activities for managing waste problems that would be suitable for their specific school. The peer leaders, teachers, and researchers worked together to create a new action plan that supported the design process, as well as the peer-led activities and the equipment needed to implement all of the action plans. Finally, all action plans were revised by peer leaders, teachers, and researchers, according to a panel of three experts.

2.3.3. Step 3: Intervention Implementation and Evaluation

Before implementing the school-based intervention program, the researchers developed an online questionnaire that assessed the relevant demographic data and existing waste management knowledge based on Andraes [15]. The questionnaire served to test the intervention's appropriateness before, immediately after, and one month after implementation of the intervention program. The waste management knowledge questionnaire included 15 items that measured knowledge about waste type, waste reduction, and waste separation, in which each item was rated on a dichotomous (yes/no) scale ranging from 0 to 15. This instrument was tested for validity and reliability, yielding a content-valid index of 0.80 and a Kuder-Richardson Formula 20 score of 0.94, respectively. After each student anonymously completed the questionnaire in the school's computer room, each action plan was implemented through collaboration among the researchers, peer leaders, and teachers over five months.

2.4. Data Analysis

Content analysis was used to analyze the qualitative data regarding waste management problems and the needs of the stakeholders. All focus group discussions and broader group discussions were audio-recorded and transcribed verbatim by the research assistant. The sixth and eighth authors then repeatedly read the transcriptions line-by-line to complete the initial coding stage. All authors verified the coding and identified the categories [21]. In addition, data obtained from the questionnaire were analyzed using one-way ANOVA to compare mean differences in waste management knowledge at three different time points. Post-Hoc testing with the Bonferroni method was used to make pairwise comparisons before, immediately after, and one month after implementation.

3. RESULTS

3.1. Waste Management Situation at the School

The waste management school policy was launched two years ago. This policy emphasized the need to create cooperation among food vendors to refrain from selling food, snacks, and drinks packed in foam boxes or plastic bags, as well as to initiate a campaign for students to reuse items and to reduce the use of hard-to-degrade materials. However, data obtained from observations determined that many sachets and plastic bags found on the tables, ground, and bushes, and in some garbage bins, had no lids and were in a damaged condition. Reflections given by informants revealed that the waste management problem in this school occurred due to two important factors contributing to a diminished awareness of the consequences of improper waste management. Firstly, many students and their families still use hard-to-degrade materials such as plastic bags, glasses, and foam boxes. Secondly, inadequate waste management knowledge was on full display as most students did not know how to separate and recycle each type of waste.

3.2. School-based Intervention Program for Waste Management

This school-based intervention program developed for waste management aimed to promote changes in attitudes and knowledge about solid waste and waste management among students in grades 4-9, which could, in turn, change their behavior for the better regarding environment and health protection. Finally, the intervention program was comprised of

four action plans: 1) empowering peer leadership; 2) supporting peer-led activities that provided knowledge through radio broadcasting, surveying the environment in the school, and setting up a waste management campaign; 3) setting up enough bins, and 4) promoting extracurricular activities that have been outlined in Table 2. Waste management knowledge could be delivered by empowering peer leadership sessions and campaign sessions for students. These consisted of defining waste types, identifying impacts on the environment and public health, the factors related to solid waste volume at the school, and specific waste management practices [22]. All action plans employed a participatory learning approach that involved elements of experience sharing, group discussions, reflections, games, skills building activities, and the viewing of video clips to enhance the peer leaders' capacity for dissemination of information and the students' knowledge and practice.

3.3. Improvement in the Waste Management Knowledge of Students

Quantitative findings from 74 students, who were asked to fill out the questionnaire before implementation, immediately after, and one month after the waste management campaign, indicated that the intervention program significantly influenced the knowledge of the participants about waste management ($F_{(2, 219)} = 10.93, p < .001$). The mean scores of waste management knowledge among students right after implementation and at the one-month follow-up point were significantly higher than those recorded before implementing the school-based intervention program ($M = 11.58, p < .05$; $M = 12.23, p < .01$, respectively), as is shown in Table 3.

Table 2. Action plans of the school-based intervention program for waste management.

Action Plans	Learning Method	Description
1. Empowering peer leadership	Training by the researcher 1.5 hours, two consecutive days	<ul style="list-style-type: none"> - Raising awareness of waste problems regarding the environment and health - Promoting knowledge of waste types, the consequence of non-waste management, and waste management (separate, reduce, reuse, and recycle waste), skills for waste separation <ul style="list-style-type: none"> - Establishing the role of peer leaders - Designing activities for waste management in the school
2. Supporting peer-led activities	Meeting 1 hour each, depending upon the peer leader's plan	<ul style="list-style-type: none"> - Empowering peer leaders to plan and implement each activity <ul style="list-style-type: none"> - Supporting peer leaders to work with their teachers - Supporting the content for radio broadcasting - Planning and designing flyers for the competition of slogan creation, inventing something from solid waste, and designing clothes from solid waste - Surveying the school with peer leaders to check littering point
3. Setting up enough bins	-	<ul style="list-style-type: none"> - Setting up two big cement tanks for organic composting waste in the school - Setting up three rubbish bins for general waste, recycled waste, and valuable waste located at five essential points including the cafeteria, the toilet building, and three study buildings.
4. Promoting extracurricular activities	Training by teachers and community leaders 3 hours Campaigning by peer leaders and primary health providers 3 hours, three months after the first training session	<ul style="list-style-type: none"> - Raising awareness of the consequences of non-waste management in the school and community - Promoting participatory learning by providing knowledge of different types of waste, the consequences of non-waste management, waste management in the school, and skills for waste separation <ul style="list-style-type: none"> - Learning how to make food and plants into compost at home and at school - Activating prior knowledge about types of waste and waste management - Promoting attitudes towards the impact of non-waste management - Giving rewards to the top three winners who competed in slogan creation, inventing something from solid waste, and designing clothes from solid waste

Table 3. Means, standard deviation, and one-way analysis of variance for the waste management knowledge scores among students before, immediately after, and one month after implementing the campaigning (n = 74).

Scores on Waste Management Knowledge	M	SD	Mean Differences	
			Immediately after Campaigning	One Month Follow-up
Baseline	10.59	2.45	-0.99*	-1.64**
Immediately after campaigning	11.58	2.01	-	-0.65
One month follow-up	12.23	1.91	-	-

Note: * p<0.05 ** p<0.01

4. DISCUSSION

These findings indicate how the R & D method was used to design the school-based intervention program to improve waste management knowledge among students in grades 4-9. This waste management intervention program was created based on the problems and needs of all stakeholders in the school, as well as by integrating the participation of peer leaders to design suitable activities that could promote positive attitudes and cultivate good habits for waste management among students. The developed intervention program was found to be appropriate and practical in a Thai rural context, where students wanted information that was concise, iterative, and easy to understand. This confirmed the outcomes of previous studies, which found that a successful intervention would need to be developed to be appropriate for each context [23]. The development of an intervention program that was suitable for each context involved the contribution of the research participants, such as discussions on the apparent problems and needs for waste management in researched settings [7, 8, 14, 17], and participant participation promotion by encouraging them all to identify and suggest waste management solutions [10, 16, 18].

Our school-based intervention program consisted of various action plans to raise awareness and promote positive attitudes and knowledge for waste management amongst participants, including 1) empowering peer leadership; 2) supporting peer-led activities; 3) setting up enough bins, and 4) promoting extracurricular activities in the school. The interventions that simultaneously included the promotion of personal knowledge, the skills of how to manage each waste type, and the improvement of a suitable environment could allow students to adopt sustainable practices for waste management [8, 16]. The action plans were similar to those of many previous studies that developed activities to improve student's knowledge and skills for waste management by integrating these concepts into the school curriculum [11, 13, 14] by promoting waste management campaigns [10, 16 - 18], and by providing enough bins appropriate for each setting [14, 16].

Moreover, this intervention program applied participatory learning through group discussions, reflections, games, the viewing of video clips, and the building of peer leader capacity in the development of strategies to raise awareness and to promote positive attitudes, knowledge, and skills among the participants for effective waste management. The results from the implementation of this program indicated that students, who participated in all action plans of the school-based

intervention program, exhibited a significant increase in waste management knowledge immediately after implementation of the program and at the one-month follow-up point when compared with the baseline data. Participatory learning is a process that triggers students or learners to share their experiences, think critically, and discuss their ideas, which might promote positive opinions and change the behavior of participants *via* group discussion [7, 24]. In addition, it could encourage peer leaders to participate in waste management practices in schools. Therefore, using a participatory learning process in a school waste management program that involves cartoon books, videos, group discussions, sharing ideas or experiences, and participating in role plays, could promote students' awareness and help students to better understand and retain the knowledge related to waste management [11, 13, 14].

Furthermore, our findings are supported by the outcomes of many prior studies that have promoted the competency of peer leaders to create and conduct practical activities in schools [10, 15, 25, 26]. Moreover, the goal of enhancing students' capacity to become competent leaders can be accomplished by teaching elements of leadership, communication, teamwork, and knowledge transfer and by engaging in activities that can improve attitudes, knowledge, self-efficacy, and practice among trained students [10, 25, 26]. Similarly, studies promoting peer education for waste management in schools and communities [10, 15, 27] have shown that competent peer leaders, who exhibit greater degrees of knowledge and confidence and who organize activities that lead to improved attitudes and the dissemination of essential information, can help students take their environmental responsibilities even more seriously and change their behaviors related to waste separation and sustainable waste management.

Although this school-based intervention program promoted positive attitudes, knowledge, and skills for more effective waste management practices, the appropriateness of this intervention program was tested only in terms of the students' waste management knowledge. Thus, this intervention program must be tested in other aspects with a more rigorous research design. In addition, participants were collected from only one school located in Lamphun, Thailand, which may not be representative of the cultural diversity across Thailand and cannot necessarily be generalized as representative of other high school students in other locations.

CONCLUSION

This developed school-based intervention program was deemed to be appropriate and practical in a Thai rural context. The intervention program was comprised of four action plans:

empowering peer leadership, supporting peer-led activities, setting up enough bins, and promoting extracurricular activities by peer leaders, teachers, and community leaders. The results of the implementation of the intervention program showed increased knowledge regarding waste management among students. Participatory learning and peer leader capacity building were key strategies that could ensure the success of the program. Therefore, the development of an effective waste management program that would be suitable in each school context, and the inclusion of associated healthcare providers, would need to be modified for each intervention program in accordance with the existing stakeholders, specifically with regard to the students' needs.

AUTHORS' CONTRIBUTIONS

WB, KI, JW, and AT contributed to the conceptualization and research design. WN and ST developed instruments and analyzed the quantitative data. WB, KI, SS, ST, and NS engaged in the research setting for data collection. SS and NS analyzed the qualitative data. SS was a major contributor to the writing of the original draft. All authors read, revised, and approved the final version of this manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This research study procedure was reviewed and approved by the Ethics Committee of the Faculty of Public Health, Chiang Mai University (study code: ET020/2562). Verbal approval was obtained from the selected school administrative committee before initiating the data collection process. Informed consent was obtained from all participants. Every student received permission from their parents. All data were presented at the group level.

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or research committees and with the 1975 Declaration of Helsinki, as revised in 2013.

CONSENT FOR PUBLICATION

Informed consent was obtained from all participants.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

The data collection tools developed during the current study are not publicly available due to funding regulations but are available from the first author upon reasonable request.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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