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The Effectiveness of Ladder Climbing Games on The Knowledge, Attitude, and Practice of Sorting Waste

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Abstract

Students' environmental knowledge is strongly related to environmental attitudes and behavior changes, which impact environmental sustainability. Game media is one of the student environmental learning methods. The study aims to evaluate two types of games (Ladder climbing and Trash trees) to increase elementary school students' knowledge, attitudes, and practices (KAP) in waste sorting. The study used a non-equivalent control group design involving 156 elementary school students in grades 4 and 5. All participants were grouped into ladder climbing games/LCG (n=156) and trash trees/TTG (n=156), then an assessment of knowledge, attitude, and practice (KAP) before and after the trial. All data were analyzed with statistical software (Alpha=0.05), with the Wilcoxon and Mann-Whitney tests. The N-Gain scores test is also applied to get the effectiveness value. The study found that most participants were aged 10 and 11 years (88.8%), and there were more female students (55.2%) than males. LCG intervention improves KAP (135.45%, 47.71%, and 92.59%) more than TTG (54.39%, 21.95%, and 54.51%). Significantly, there were differences in KAP values before and after the intervention and between the two types of intervention (p-value <0.05). Study has also found that the LCG method is more effective than the TTG (N-Gain score > 70%). The study has proven that the game method (LCG and TTG) can improve students' KAP in waste sorting. However, the LCG method is more effective than the TTG. The game method is a wise choice to apply to elementary school education so that it is expected to shape environmental behavior.

Keywords: Game, KAP, Ladder Climbing, Trash Tree, Waste.

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1. INTRODUCTION

Waste is the residue of human activities or natural processes in solid form (Pemerintah Indonesia, 2008). Community consumption patterns contributed to the causes of waste in Sleman in 2018 of 8,000 m^3 per day (Pemerintah Daerah Kota Yogyakarta, 2018). According to Kementerian Kesehatan Republik Indonesia, (2014), one of the indications of a community living clean and healthy is managing waste. Waste management must be carried out comprehensively and integrated from upstream to downstream. The upstream aspect is waste management activities at the generation (source) level and sorting waste (Sucipto, 2012).

Primary education plays a vital role in shaping environmental behavior. The students' low environmental knowledge is related to the teacher's lack of practical experience in sustainable waste management for environmental sustainability. Environmental sustainability can be achieved when environmental attitudes, environmental awareness, and environmental knowledge are connected or communicated from teachers to students (Adeolu, Enesi, & Adeolu, 2014; Debrah, Vidal, & Dinis, 2021; Kwan & Stimpson, 2003; Pavlátová, 2017). According to Yusuf & Nurihsan (2006), elementary period can be called an intellectual stage, which is a realistic stage, curious about something and learn. Games are a way of learning that can be done in elementary schools to increase students' knowledge and understanding, which will then shape behavior (Basiroen, Purbasari, & Yuliana, 2021; Dzakirotillah, Suwerda, & Istiqomah, 2018; Frost & Wortham, 2021; Jørgensen, Madsen, & Læssøe, 2018; Kamid, Sofnidar, Septi, & Citra, 2021; Munthe, 2020; van Amstel & Teixeira Carneiro, 2020; Yudianto, Mukarromah, & Yani, 2012). Several studies have also reported that knowledge interventions on how to sort waste through games have been able to improve knowledge and practice of good waste sorting (Dzakirotillah et al., 2018; Gunn & McCallum, 2005; Pavlátová, 2017; Solikha, Suchainah, & Rasyida, 2020; van Amstel & Teixeira Carneiro, 2020).

A preliminary study was conducted on January 5, 2021, with 20 students (10 students in grade IV and 10 students in grade V at SD Negeri Kanoman) by providing questions about waste, types of waste, and waste segregation practices. The preliminary study results found that 17 (out of 20 students) knew the meaning of waste, and only 5 (out of 20 students) knew the type. Even though 18 (out of 20 students) stated that they could sort waste, the practical results showed that waste was still mixed based on its type. The study results also found that the school has provided different trash cans according to the type, but students have yet to sort waste properly.

Several learning methods at the school-age stage include speeches, interactive games, puzzles, matching, and role play (Frost & Wortham, 2021; Kamid et al., 2021; Mustafa & Yusoff, 2011; van Amstel & Teixeira Carneiro, 2020). Games provide several stimuli for children to increase their knowledge about environmental health problems (Dzakirotillah et al., 2018; Fitriastuti, 2015; Gunn & McCallum, 2005; Munthe, 2020; Oktaviani, Kertin, Dahliani, & Komalasari, 2022; Yudianto et al., 2012). Games are also a form of recreation and can benefit children's development (Frost & Wortham, 2021; Ivy, Road, Lee, & Chuan, 1998; Jørgensen et al., 2018; Mustafa & Yusoff, 2011; Yusuf & Nurihsan, 2006).

One game that aims to improve students' knowledge, attitudes, and practices (KAP) in waste sorting is the Trash-Tree Game (TTG). According to Aini (2020), TTG can significantly increase the value of knowledge (56.34%), attitude (26.61%), and practice (146.39%). Although the research results have generally yielded encouraging results, the increase in the value of knowledge and attitudes is still low, possibly due to the lack of student participation in the game. According to Gunn & McCallum (2005), games should be able to attract students' interest to be actively involved and interact with each other, so that the impact on increasing knowledge, attitudes, and skills.

In this study, Ladder-climbing games (LCG) were developed. This game is similar to the snack and ladder games but differs in the design of the board game. This game contains the meaning and types of waste, how to sort waste and the appropriate trash can. The study aims to evaluate the effectiveness of two game interventions (Ladder-climbing games/LCG and Trash-tree games/TTG), to increase students' KAP in sorting waste.

2. RESEARCH METHOD

This study is a quasi-experimental study with a non-equivalent control group design. The study was conducted in March-July 2021 after obtaining approval from the Health Research Ethics Committee, Politeknik Kesehatan Kementerian Kesehatan Yogyakarta (No.LB.01.01/KE-01/VIII/282/2021). Guided by the Helsinki protocol, consent is taken, and data handling is confidential. There is no risk of harm to participants, participants have the right to withdraw during the study, and all procedures are explained before intervention.

This study involved 116 students from SD Negeri Kanoman and SD Negeri Patran, Bantul Regency, Yogyakarta. The determination of the two schools is purposive, considering the similarities in their characteristics (location, school status, and curriculum). Randomly, SD Negeri Kanoman was in LCG, and SD Negeri Patran was assigned to TTG. Each school randomly selected 58 fifth and sixth-grade students. The determination of fifth and sixth graders as research subjects follows Djamarah (2011), that students are 9-12 years old, already have realistic observations, can think critically and logically, and have a high curiosity. All participants were grouped into two groups (LGC and TTG). This game contains sorting waste, including types of waste, sorting, collecting, and processing.

Data collection uses a written test to measure knowledge and attitudes and a checklist to measure sorting waste practices. The tools used in the study were: 1) questions to measure knowledge and attitudes, 2) a checklist to measure practices, 3) LCG and TTG equipment, and 4) samples of organic, inorganic, and hazardous waste.

The study was carried out starting with the pre-test to measure students' KAP before the intervention, the waste sorting education intervention with two types of games (LGC and TTG), and the post-test to measure the effect of the intervention on students' KAP. The measurement procedure for the post-test is the same as for the pre-test and uses the same questions. The post-test was carried out after all participants received education on waste sorting using the game method. The difference between the pre-post scores and the post-test average measures changes in KAP.

Knowledge is students' understanding of types of waste, types of waste containers, and how to sort waste. Knowledge is measured using 12 written questions in multiple-choice form. Measurements were made once in the pre-test and three times in the post-test. Correct answers get a value of 1, and wrong answers get 0.

Attitude is the student's response and acceptance of statements about sorting waste according to its type. The attitude was measured with ten written questions using a Likert Scale of five favorable and five unfavorable statements. In a favorable statement, a value of 1 if choosing "agree" and 0 if "disagree". The assessment is the opposite of the unfavorable statement. Attitudes were measured once in the pre-test and three times in the post-test.

Practice is the action taken by students in sorting waste. The measurement is carried out using a checklist which the author will fill in based on the respondent's practice in sorting the waste samples provided. If the respondent is correct in placing the waste, he will get a value of 1; if he is wrong, he will get a value of 0. The maximum score obtained is 6. The practice of sorting waste is measured with a pre-test and three post-tests. Waste sorting education is carried out with two types of games, namely LCG (experiment) and TTG (control). Participants in each type of game are divided into 5-6 groups. Each group can play one type of game (three repetitions) according to the previously described game instructions.

Data is entered into statistical software after being checked for completeness, edited, and coded. Then performed univariate and bivariate analysis. Univariate to obtain the characteristics of each variable. Bivariate to assess the effect of the intervention.

Before the bivariate test stage, a normality test (Kolmogorov-Smirnov Test) was carried out to determine the data distribution. The Wilcoxon test was applied to determine differences in variable values (KAP) before and after the intervention. Meanwhile, the Man-Whitney test was used for differences in variable values (KAP) between the two types of intervention (LCG and TTG). The analysis was performed at a 95% confidence level ($\alpha = 0.05$).

In the final section, n-Gain scores are analyzed to evaluate the effectiveness of the intervention method (LCG and TTG) to increase KAP. N-Gain scores are calculated based on the difference between the pre-test and post-test values against the ideal score. The interpretation of the N-Gain scores is: "High-g" courses as those with (<g>) > 0.7; "Medium-g" courses as those with 0.7 > (<g>) > 0.3; "Low-g" courses as those with (<g>) < 0.3 (Hake, 1999; Sihaloho, Sahyar, & Ginting, 2017; Solikha et al., 2020).

3. RESULTS AND DISCUSSION

Table 1. Characteristic of participants

Characteristics	**LCG n (%)**	**TTG n (%)**	**N (%)**
Gender			
Male	28 (48.3)	24 (41.4)	52 (44.8)
Female	30 (51.7)	34 (58.6)	64 (55.2)
Age (years)			
9	8 (13.8)	2 (3.4)	10 (8.6)
10	25 (43.1)	26 (44.8)	51 (44.0)
11	24 (41.4)	27 (46.6)	51 (44.0)
12	1 (1.7)	2 (3.4)	3 (2.6)
13	0 (0.0)	1 (1.7)	1 (0.9)

A total of 116 students participated in the study, half in the LCG group and the rest in the TTG group. Table 1 shows more female participants (55.2%) than males. Most participants (88.8%) were aged 10 and 11 years. The lowest age is nine years, and the highest is 13 years.

Table 2. Average of Pre and post-test scores

Intervention	**Variable**	**Pre-test (Min-max)**	**Post-test (Min-max)**	**Increase (%)**
LCG	Knowledge	4.3 (1.0-8.0)	10.3 (7.0-12.0)	135.45
	Attitude	6.0 (2.0-8.0)	8.9 (6.0-10.0)	47.71
	Practice	2.8 (0.0-5.0)	5.4 (3.3-6.0)	92.59
TTG	Knowledge	4.9 (3.0-9.0)	7.6 (4.0-11.0)	54.39
	Attitude	7.1 (3.0-9.0)	8.7 (5.0-10.0)	21.95
	Practice	2.9 (0.0-5.0)	4.5 (2.0-6.0)	54.51

In the LCG group (Table 2), the student knowledge increased by 135.45%, from 4.3 (1.0-8.0) to 10.3 (7.0-12.0). Student attitudes increased by 47.71%, from 6.0 (2.0-8.0) to 8.9 (6.0-10.0). Meanwhile, in practice, there was an almost double increase (92.59%), from 2.8 (0.0-5.0) to 5.4 (3.3-6.0).

Even though it shows an increasing trend, the increase in TTG interventions is smaller than that of LCG (Table 2). The students' knowledge scores increased by 54.39%, from 4.9

(3.0-9.0) to 7.6 (4.0-11.0). Attitude increased from 7.1 (3.0-9.0) to 8.7 (5.0-10.0), or 21.95%. The practice increased by 51.51%, from 2.9 (0.0-5.0) to 4.5 (2.0-6.0).

Table 3. Normality test results.

Intervention	Variabel	Pre-test		Post-test	
		p-value	Interpretation	p-value	Interpretation
LCG	Knowledge	0.000*	Non-normal	0.000*	Non-normal
	Attitude	0.000*	Non-normal	0.000*	Non-normal
	Practice	0.016*	Non-normal	0.000*	Non-normal
TTG	Knowledge	0.000*	Non-normal	0.009*	Non-normal
	Attitude	0.000*	Non-normal	0.000*	Non-normal
	Practice	0.000*	Non-normal	0.000*	Non-normal

A normality test was performed with the Kolmogorov Smirnov. The analysis results (Table 3) show that the values of all variables (KAP) in both types of intervention are non-normal distributed (p-value <0.05). Based on the results of this test, bivariate analysis was performed using non-parametric statistics, using the Wilcoxon and Mann-Whitney tests.

Table 4. Wilcoxon's test results.

Intervention	Variable	Pre-test (Min-max)	Post-test (Min-max)	p-value
LCG	Knowledge	4.3 (1.0-8.0)	10.3 (7.0-12.0)	0,0001
	Attitude	6.0 (2.0-8.0)	8.9 (6.0-10.0)	0,0001
	Practice	2.8 (0.0-5.0)	5.4 (3.3-6.0)	0,0001
TTG	Knowledge	4.9 (3.0-9.0)	7.6 (4.0-11.0)	0,0001
	Attitude	7.1 (3.0-9.0)	8.7 (5.0-10.0)	0,0001
	Practice	2.9 (0.0-5.0)	4.5 (2.0-6.0)	0,0001

KAP measurements were carried out once in the pre-test and three repetitions in the post-test. In the LCG method (Table 4), there is a significant difference in KAP scores before and after the intervention (p-value <0.05). Intervention with TTG also showed a significant difference.

Table 5. Man-Whitney and N-Gain score test results.

Variables	Intervention	p-value	N-Gain score	Category
Knowledge	LCG	0.0001*	0.77	High
	TTG		0.38	Medium
Attitude	LCG	0.0001*	0.73	High
	TTG		0.53	Medium
Practice	LCG	0.0001*	0.81	High
	TTG		0.52	Medium

The Man-Whitney test results (Table 5) show a significant difference in knowledge between the LCG and TTG methods (p-value <0.05). Similarly, the Attitude and Practice variables also show significant differences (p-value <0.05).

The results of the analysis of N-Gain scores (Table 5) show that the LCG method is more effective for increasing knowledge about waste sorting (N-Gain scores = 0.77) compared to the TTG method (N-Gain scores = 0.38). Likewise, in attitude and practice, the LCG method is more effective (N-Gain scores = 0.73 and 0.81) than the TTG method (N-Gain scores = 0.53 and 0.52). These results conclude that the LCG method is more effective than the TTG in improving KAP students' waste sorting.

The study results (Table 2) show that LCG can increase students' knowledge in sorting waste by 135.45%, or from 4.3 (1.0-8.0) to 10.3 (7.0-12.0). The results of the statistical analysis (Table 4) proved a significant difference between the pre and post-test (p-value <0.05). Although TTG also increased students' knowledge, the increase in knowledge scores was only 54.39%, from 4.9 (3.0-9.0) to 7.6 (4.0-11.3).

The Man-Whitney and N-Gain scores test identified a comparison of the two methods (Table 5). Both methods showed significant differences (p-value <0.05). N-Gain scores analysis shows that the value of the LCG method is 77.0%, while the TTG is 38.0%. These results prove that the LCG method is more effective for increasing knowledge of waste sorting than TTG. N-Gain scores > 70% indicate that the intervention method is in the effective category (Hake, 1999; Sihaloho et al., 2017; Solikha et al., 2020).

Knowledge is the result of one's knowledge of objects through the five senses they have. The ears and eyes are senses that have more influence on one's knowledge (Notoatmodjo, 2014). Knowledge is essential in determining behavior and influencing decision-making (Samdin, Bakori, & Hassan, 2012). LCG makes respondents actively use their eyes and ears in playing games. The eyes see every step and question card, and the ears listen to the questions. Coordination of the two senses increased respondents' knowledge in sorting waste compared to the TTG method.

Games are designed with attractive pictures and writing, so players can understand and memorize them quickly. In the game, players are required to win the competition actively. If unable to answer the question, the player cannot advance to the next step. Games have rules, goals, choices, challenges, points, and criteria for winning or losing (Prensky, 2007). Games are a stimulus that can be given to children to increase knowledge about health problems in their environment (Yudianto et al., 2012).

Several studies have reported the game method to increase students' knowledge. Three-dimensional box games can increase students' waste sorting knowledge by around 5.13% (Munthe, 2020), sorting card games can increase students' knowledge by 55.14% (Dzakirotillah et al., 2018), and TTG can increase by around 56.34% (Aini, 2020). Compared to the previous game, the LCG method can improve students' knowledge better (135.45%).

The effect of the game method (Table 2) shows that LCG can improve student attitudes by around 47.71%, from 6.0 (2.0-8.0) to 8.9 (6.0-10.0). Meanwhile, the TTG increased by around 21.95%, from 7.1 (3.0-9.0) to 8.7 (5.0-10.0). The two-game methods significantly (p-value <0.05) have a changing effect on students' attitudes in sorting waste (Table 4). However, the LCG method (Table 5) shows higher effectiveness (N-Gain scores = 73.0%) than TTG (N-Gain scores = 53.0%).

Attitude is a way of thinking or feeling about something that can cause changes in behavior (Fitriastuti, 2015; Frost & Wortham, 2021; MacBlain, 2018; Notoatmodjo, 2014). It also depends on a person's beliefs about the results of his actions, whether positive or negative (Gunn & McCallum, 2005). In the game, indications of attitude can be seen from players' efforts in answering right and wrong questions (Mustafa & Yusoff, 2011). In LCG, the communication element is contained in the question cards that must be answered correctly to play to the end. For that, players must be active and compete in answering questions. In answering, respondents can provide ideas and responses in providing answers.

LCG increased attitude by around 47.71%, while TTG increased by 21.95%. The results showed that the LCG method had a more significant impact on improving students' attitudes toward sorting waste. According to Gunn & McCallum (2005), games are another way to help students learn. Knowledge alone is not enough to motivate individuals to change their behavior, but a strong positive attitude will maintain certain behaviors in the long term (Dzakirotillah et

al., 2018; Mustafa & Yusoff, 2011). According to Adeolu et al. (2014), every activity must begin with adequate knowledge, which will drive attitude change.

In this study (Table 2), an increase in aspects of training with LCG was obtained by around 92.59%, from 2.8 (0.0-5.0) to 5.4 (3.3-6.0). Meanwhile, the TTG was around 54.51%, from 2.9 (0.0-5.0) to 4.5 (2.0-6.0). Statistically, there was a significant difference between before and after the intervention (p-value <0.05). These results indicate that the LCG method provides a more significant effect than TTG.

Table 5 shows that the effect of practice in sorting waste from the two-game methods is significantly different (p-value <0.05). However, the LCG method shows higher effectiveness (N-Gain scores = 73.0%) than TTG (N-Gain scores = 53.0%). LCG method can be applied to improve KAP students in sorting waste.

The study results confirmed the previous study that the game method can improve students' KAP in sorting waste. The results presented by Dzakirotillah et al., (2018) with the sort card game method, Munthe (2020) with a three-dimensional box game, and Aini (2020) with a trash tree game.

Training is a personal process after a stimulus, assessment, or opinion of what they know (Frost & Wortham, 2021; MacBlain, 2018; Notoatmodjo, 2014). Games provide several stimuli to children to increase their knowledge, attitudes, and practices regarding health issues (Frost & Wortham, 2021; Gunn & McCallum, 2005; Notoatmodjo, 2014; Oktaviani et al., 2022; Yudianto et al., 2012). In addition, games are also a form of recreation that is beneficial to the psychological development of children (Frost & Wortham, 2021; Jørgensen et al., 2018; MacBlain, 2018; Mustafa & Yusoff, 2011; Yusuf & Nurihsan, 2006).

According to Notoatmodjo (2014), several methods are used in health promotion, including the game method. Games in learning have several advantages in that they can help improve students' cognition, which ultimately shapes behavior (Frost & Wortham, 2021; MacBlain, 2018). Three main factors determine behavior: predisposing, enabling, and reinforcing (Green, Kreuter, Deeds, & Partridge, 1991; Notoatmodjo, 2014). Predisposing are attitudes, knowledge, beliefs, values, and personality factors influenced by individual or group motivation. Enabling factors are factors that allow a behavior to occur. Enabling factors are also supporting factors, including facilities or infrastructure, environmental conditions, and community resources in the environment (Kreuter et al., 2007; Kreuter & Wray, 2003).

In this study, education using the game method was carried out in three replications to increase students' understanding of waste sorting. According to Bandura (1977), one of the learning phases is the retention phase. In the retention phase, the subject matter will be remembered for a long time if repeated. Retention is storing new understandings and behaviors obtained after receiving information. Giving information that is done repeatedly affects the survival of the material that has been studied.

4. CONCLUSION

The study results prove that the game method can improve students' KAP in environmental management. However, the LCG method had a better effect on increasing KAP (135.45%, 47.71%, and 92.59%) than TTG (54.39%, 21.95%, and 54.51%). The N-Gain Score analysis (> 70%) has also proven that the LCG method is more effective for increasing the KAP of elementary school students in sorting waste. The change in the tutorial teaching method to a game method in environmental education for elementary school children is highly expected so that environmental behavior is formed from an early age.

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