INTEREST: Jurnal Ilmu Kesehatan
Vol. 13, No. 2, November 2024
https://doi.org/10.37341/interest.v13i2.599

Original Research

Playing Puzzles Improves School-Age Children's Handwashing Knowledge and Skills

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ABSTRACT

Background: *Handwashing with soap and water is crucial for preventing the spread of infectious diseases like diarrhea. This study aimed to evaluate the impact of health education using puzzle-based learning on the handwashing knowledge and skills of elementary school students in Loa Janan Ilir.*

Methods: *A quasi-experimental design with a non-random control group was employed. Students from SDN X (treatment group) received puzzle-themed educational materials, while SDN Y (comparison group) received PowerPoint presentations. Each group comprised 53 students, selected using proportional stratified random sampling. Knowledge was assessed via a questionnaire, and handwashing skills were observed using a checklist. Data analysis involved Wilcoxon and Mann-Whitney tests at a 95% confidence interval.*

Results: *The analysis revealed significant improvements in both knowledge and skills in the treatment group compared to the comparison group, with knowledge p=0.032 and skills p<0.0001 with a 95% confidence interval.*

Conclusion: *The use of puzzle-based health education significantly enhanced handwashing knowledge and skills among students at SDN X. These findings suggest that health centres could effectively use puzzle media for promoting handwashing practices among elementary school children.*

ARTICLE HISTORY
Received: October 11th, 2023
Accepted: September 25th, 2024

KEYWORDS
education, handwashing, knowledge, puzzle, skills;

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Cite this as: Yuliana, Y., Chifdillah, N. A., Rahayu, E. P., & Hendriani, D. (2024). Playing Puzzles Improves School-Age Children's Handwashing Knowledge and Skills. *Interest : Jurnal Ilmu Kesehatan*, *13*(2), 98–111. https://doi.org/10.37341/interest.v13i2.599

INTRODUCTION

Schools and madrasahs play an important role in educating students about health and hygiene behavior. One of the indicators of clean and healthy living behaviour **(**PHBS) in schools is handwashing with soap (CTPS). CTPS practices with running water are one of the most basic hygiene practices that are globally recognized and have a major impact on health. One of the benefits of CTPS is a fundamental effort to prevent the spread of infectious diseases (Kemendikbud, 2020).

By 2019, diarrhea will have replaced infant mortality as the main cause of death in children under the age of five around the world. This equates to over 484,000 children dying each year, or more than 1,300 children dying every day despite easy treatment alternatives (UNICEF, 2019). In 2013, 3.5% of Indonesians suffered from diarrhea

(Kemenkes RI, 2018). Based on the 2023 Indonesian Health Survey, the prevalence of diarrhea based on diagnosis or symptoms at all ages nationally was 4.3%, and the prevalence of diarrhea at all ages in East Kalimantan Province was 4.2% (Kemenkes RI, 2023). Based on data from the Central Statistical Authority (BPS) of East Kalimantan Province, the number of cases of diarrhea in East Kalimantan in 2019 was 68,256 (BPS Kalimantan Timur, 2019).

According to the data provided by Central Statistical Authority (BPS) Samarinda in 2019, there was an increase in the number of diarrhea cases in Samarinda City compared to the previous year. Specifically, in 2018, there were 10,988 cases reported, while in 2019, the number increased to 11,088 cases (BPS Samarinda, 2019). According to statistics provided by the Samarinda City Health Service in 2021, it has been determined that there were a total of 3,595 cases of diarrhea reported across all age categories within Samarinda City.

Trauma Center Community Health Center, located in the Loa Janan Ilir area, exhibits the most significant prevalence of diarrhea cases within the city of Samarinda. Based on the statistics provided by the Samarinda City Health Service in 2021, there were 245 cases of diarrhea reported among individuals aged 5 years and older. Among individuals aged 8–11 years, there were 103 cases of diarrhea. In total, across all age categories, the number of reported diarrhea cases amounted to 372.

One of the steps a child can take to prevent diarrhea is to regularly wash their hands with soap. This can reduce the risk of diarrhea by up to 30% (Kemenkes RI, 2021). Efforts to improve children's knowledge and skills about CTPS are through health education. Health education is an organized and ever-changing learning network. The focus of this learning is to change behavior by improving skills and knowledge, as well as changing attitudes associated with improving lifestyles toward a healthier lifestyle (Nurmala et al., 2018).

The media is an important component of health education. With the media, it becomes easier for the target to receive and understand the message delivered because the message is delivered in an interesting way. Media puzzle is one of the media that can be used when doing health education (Jatmika, Maulana, Kuntoro, & Santi, 2019).

Puzzle media influences the knowledge and behavior of CTPS in children. Puzzle medium has several advantages, such as training concentration, accuracy, and patience, strengthening memory, and introducing students to systems and relationship concepts (Palupi, Farikah, Wasilah, & Sismulyasih, 2023). This is in line with a study that stated that puzzle play therapy has an effect on increasing students' knowledge about hand washing with soap (Hikmah, 2019).

This is also in line with a study that stated that after being given health education with puzzle media, the results showed a difference in handwashing behavior with soaps between the control group and the treatment group (Dewi, Kusumaningsih, & Suntari, 2019). This is consistent with a study that stated that after being given a puzzle game intervention, students are able to demonstrate the 6-step hand hygiene technique properly and correctly, so there is an effect of health education using puzzle media on hand hygiene behavior in school-age children (Maelissa & Ukru, 2020). The researchers conducted the preliminary study on November 26, 2022, in the Trauma Center Community Health Center working area at SDN X Loa Janan Ilir.

Based on the findings of the researchers' preliminary study with students in class 6A, it is known that out of 23 students, 9 (39%) had experienced diarrhea in the previous year. In addition, it was known that of the 23 students, there were 19 students

with poor knowledge of CTPS (83%), and 4 students with sufficient knowledge about CTPS (17%). Out of 23 students, there were 21 students that were unskilled in performing CTPS steps (91%). Based on the background description, it is important to do research about "Playing Puzzles Improves School-Age Children's Handwashing Knowledge and Skills". This study generally aims to analyse the effect of health education with puzzle media on the knowledge and skills of students in one of the schools in the Loa Janan Ilir area.

MATERIALS AND METHOD

This study was quasi-experimental and utilized a non-randomized control group design. The population in this study were all students enrolled in SDN X Loa Janan Ilir and SDN Y Loa Janan Ilir. The researchers conducted the study in two schools. Two groups of respondents were created: the intervention group and the control group. The intervention group respondents were SDN X Loa Janan Ilir students, while the control group respondents were SDN Y Loa Janan Ilir students.

The sample of this study consisted of 106 grade 5 students. The sampling method was stratified proportional sampling. Each group consisted of 53 students as respondents. To control bias, the researcher set inclusion and exclusion criteria. Inclusion criteria in this study include being actively registered as a student at the research location, students aged 10-11 years, students who are physically and mentally healthy, students who can read and write, students who are willing to become research respondents, and students who bring informed consent and have been approved by parents to become research respondents.

Exclusion criteria include students who did not participate in complete data collection and students who did not complete the questionnaire. The intervention group received health education through puzzle-based media, while the control group used PowerPoint-based media. The data were collected using primary data collection techniques. Using instruments that had been tested for validity and reliability, primary data was collected.

The validity and reliability test of this research questionnaire was conducted on 23 students at SDN Z Loa Janan Ilir based on the geographical proximity of the school to the Trauma Center Health Center area. The determination of validity is done by comparing the value of the r-product moment with the results of the calculation of the r-table, which is 0.4132. If the r-count is greater than the r-table and the value is positive, then the question is declared valid. The results of the validity test are presented in the following table:

Table 1. Research Questionnaire Validity Test Results

Statement	R-Count	R-Table	Description
X1	0,948	0,413	Valid
X2	0,897	0,413	Valid
X3	0,965	0,413	Valid
X4	0,835	0,413	Valid
X5	0,897	0,413	Valid
X6	0,965	0,413	Valid
X7	0,965	0,413	Valid
X8	0,965	0,413	Valid
X9	0,262	0,413	Invalid

Statement	R-Count	R-Table	Description
X10	0,327	0,413	Invalid
X11	0,965	0,413	Valid
X12	0,309	0,413	Invalid
X13	0,965	0,413	Valid
X14	0,835	0,413	Valid
X15	0,897	0,413	Valid
X16	0,965	0,413	Valid
X17	0,965	0,413	Valid
X18	0,965	0,413	Valid
X19	0,299	0,413	Invalid
X20	0,698	0,413	Valid
X21	0,272	0,413	Invalid
X22	0,897	0,413	Valid
X23	0,965	0,413	Valid
X24	0,847	0,413	Valid
X25	0,948	0,413	Valid

Based on the results of the validity test, the results obtained are that of the 25 questions that have been tested, there are 5 invalid questions. The number of valid questions is 20 questions (Table 1). The reliability test of this study used the Cronbach Alpha method. The more the reliability coefficient approaches 1.00, the higher the reliability. Based on the results of the reliability test, the results obtained show that the questionnaire that was tested has an Alpa Cronbach value of 0.741, which means that the question items on the research questionnaire are reliable.

This study utilized a knowledge questionnaire and a skill checklist as its instruments. This study utilized both univariate and bivariate data analysis. In categorizing respondents' responses, univariate analysis describes the frequency distribution and proportion of each dependent variable and independent variable. Using the Wilcoxon test, which examines the effect of health education, and the Mann-Whitney test, which examines differences between the two groups, a bivariate analysis was conducted.

This research has also been ethically qualified by the East Kalimantan Ministry of Health Polytechnic Health Research Ethics Commission with letter number DP.04.03/7.1/9157/2023.

RESULTS

The results of the research that has been completed are described below:

Table 2. Characteristics of Respondents

Characteristics	Group			
	Intervention (n = 53)		Control (n = 53)	
	(n)	(%)	(n)	(%)
Age				
10 years old	2	3.8	1	1.9
11 years old	**51**	**96.2**	**52**	**98.1**
Gender				

Characteristics	Group			
	Intervention (n = 53)		Control (n = 53)	
	(n)	(%)	(n)	(%)
Male	**28**	**52.8**	**28**	**52.8**
Female	25	47.2	25	47,2
Parent's Educational Background				
Elementary School	2	3.8	1	1.9
Junior High School	5	9.4	3	5.7
Senior High School	**38**	**71.7**	**44**	**83.0**
College/University	8	15.1	5	9.4
Exposure to Information on CTPS from the Health Center				
Ever	**30**	**56.6**	**38**	**71.7**
Never	23	43.4	15	28.3

The respondents (51, or 96.2%) in the intervention group and 52, or 98.1%, in the control group were 11-year-old students, based on an examination of characteristics by age of the respondents. There were a total of 28 male students (52.80%) in the intervention group and the control group, according to the analysis of characteristics based on the gender of the respondents. Analysis of respondent characteristics by parental education level revealed that among the 38 adolescents in the intervention group (71.7%) and 44 students in the control group (83.0%), the vast majority of parents had at least a high school education. Most respondents in the intervention group had been exposed to material regarding CTPS, with as many as 30 students (56.6% of the sample) receiving such exposure compared to 38 students (71.7% of the sample) in the control group (Table 2).

Table 3. Effect of Health Education on Knowledge about Handwashing with Soap (CTPS) in the Intervention and Control Groups between Pre Test and Post Test

Variable	Group							
	Intervention (n = 53)				Control (n = 53)			
	Pre Test		Post Test		Pre Test		Post Test	
	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
Knowledge								
Well	22	41.5%	38	71.7%	19	35.8%	28	52.8%
Enough	26	49.1%	15	28.3%	31	58.5%	22	41.5%
Not enough	5	9.4%	0	0%	3	5.7%	3	5.7%
ρ-value	0.001				0.072			

A statistically significant impact was observed in the knowledge of respondents before and after receiving health education through Puzzle Media. The significance value for knowledge ($\rho = 0.001$) was found to be less than the predetermined significance level α of 0.05, leading to the rejection of the null hypothesis (H0) (Table 3). The statistical analysis reveals that the implementation of health education via puzzle media has a noteworthy impact on students' understanding of Handwashing with Soap (CTPS) at SDN X Loa Janan Ilir.

No statistically significant impact was observed on respondents' knowledge after receiving health education through slide PowerPoint media. The significance value for knowledge (ρ=0.072) is above the predetermined alpha level of 0.05, indicating that the null hypothesis (H0) cannot be rejected (Table 3). The results of statistical tests explain that health education with slide PowerPoint media does not have a significant effect on student knowledge about handwashing with soap (CTPS) at SDN Y Loa Janan Ilir.

Table 4. Effect of Health Education on Handwashing with Soap (CTPS) Skills in the Intervention and Control Groups between Pre Test and Post Test

Variable	Group							
	Intervention (n = 53)				Control (n = 53)			
	Pre Test		Post Test		Pre Test		Post Test	
	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
Skills								
Skill	4	7.5%	53	100%	3	5.7%	6	11.3%
Unskilled	49	92.5%	0	0%	50	94.3%	47	88.7%
ρ-value	<0.0001				0.257			

A statistically significant impact was observed on the skills of the respondents following the provision of health education through puzzle media, as indicated by a significance value of skills (ρ<0.0001) (Table 4). This finding suggests that the null hypothesis (H0) can be rejected, as the ρ-value is less than the predetermined significance level of α 0.05. The statistical analysis reveals that the utilization of puzzle media in health education has a noteworthy impact on the development of students' skills pertaining to Handwashing with Soap (CTPS) at SDN X Loa Janan Ilir.

No statistically significant impact was observed on respondents' abilities before and after receiving health education through slide PowerPoint media. The significance value for skills is ρ=0.257, which is greater than the predetermined significance level α of 0.05 (Table 4). Consequently, the null hypothesis (H0) cannot be rejected. The statistical test results explain that health education with slide PowerPoint media does not significantly affect student skills in handwashing with soap (CTPS) at SDN Y Loa Janan Ilir.

Table 5. Differences in Knowledge of Handwashing with Soap (CTPS) in the Intervention and Control Groups After the Intervention

Variable	Group			
	Intervention (n = 53)		Control (n = 53)	
	(n)	(%)	(n)	(%)
Knowledge				
Well	38	71.7%	28	52.8%
Enough	15	28.3%	22	41.5%
Not enough	0	28.3%	3	5.7%
ρ-value	0.032			

The Mann-Whitney test yielded a ρ-value of 0.032 (ρ<α 0.05) for the time period following the intervention (Table 5). This indicates that there exists a statistically

significant disparity in the level of handwashing knowledge with soap among both groups of participants subsequent to receiving health education.

Table 6. Differences in Handwashing with Soap (CTPS) Skills in the Intervention and Control Groups After the Intervention

Variable	Group			
	Intervention (n = 53)		Control (n = 53)	
	(n)	(%)	(n)	(%)
Skills				
Skill	53	100%	6	11.3%
Unskilled	0	0%	47	88.7%
ρ-value	<0.0001			

The Mann-Whitney test obtained a ρ-value of <0.0001 at the time after the intervention. This result supports the research hypothesis because (ρ<α 0.05), which means there is a difference in handwashing with soap skills between the intervention group and the control group after being given health education (Table 6).

DISCUSSION

Characteristics of Respondents

The age of a person is the amount of time that has passed from the beginning of their existence. Normal people all appear to be at the same stage of anatomical and physiological development when viewed from the perspective of time. One's age can also be thought of as the time that has passed since their birth. The majority of participants in both the experimental and control groups were eleven years old.

This is in line with the research, which showed that most of the respondents in the study were 11 years old (Triswanti, Anggunan, Farich, & Mevia, 2023). At the age of 11, children can already think about something that has the possibility of happening (abstract), which, when compared to the previous stage, namely systematic and logical thinking on real objects (empirical), of course, has entered a new stage (Piaget in Daud, Siswanti, and Jalal 2021). However, the results of this study are not in line with research conducted by Kartika et al., in Ikasari & Anggana (2020), which examines the factors associated with hand washing with soap behaviour and states that there is no relationship between age and hand washing behaviour.

Gender is the defining feature that separates human beings into two distinct sexes. This study found that in both the experimental and control groups, the majority of participants were males. This is in line with research that showed that the majority of respondents were male (Ningsih, 2021). Women are more likely than men to properly wash their hands after using the restroom. During their time in school, girls tend to develop quickly.

Because of their superior stature, strength, and dexterity with fine motor skills, girls are more likely to place a premium on grooming (Ikasari, Setiawan, & Sukihananto, 2020). This is in line with research that states that there is a relationship between gender and handwashing behaviour using soap (Riadini & Setyorini, 2022). However, the results of this study are not in line with research that states that there is no significant difference in proportion between gender variables and handwashing with soap behaviour among students (Purnama, Eliandy, & Lestari, 2020).

The respondent's greatest degree of formal education is the one attained by his or her parents, as evidenced by the certificate in question or the respondent's own recollection. The majority of respondents' parents in both the intervention and control groups were high school graduates, according to the findings of this study. This is in line with the results of the study, which showed that the characteristics of respondents in the study based on parental education obtained the most respondents with the latest high school education (Kusuma Astuti & Trisnowati, 2021). Parents with greater education are more patient and empathetic when helping their children learn (Soetjiningsih & Ramuh, 2018).

One's "exposure" to data on CTPS is measured by how often one receives updates from the local health department. The majority of participants in both the intervention and control groups in this study reported learning about CTPS. The CTPS information provided to respondents came from the public health center. This is in line with the results of the study, which states that exposure to information is obtained through health workers from the nearest health centre because health workers from the health center routinely visit schools once a month to provide information through health promotion (Trijayanti, 2019).

Individual knowledge can be obtained through several ways, such as formal education or learning processes, personal or other people's experiences, and through the media. The information obtained will then be stored in their memory through the use of the five senses (Subaris, 2016). This is also in line with the results of the study, which showed that there was a significant relationship between information exposure and handwashing with soap behaviour in students. Students who are not exposed to information about CTPS are likely to have poor CTPS behaviour by four times compared to students who are exposed to information about hand washing with soap (Setiaji, Fitri, & PH, 2020).

Effect of Health Education on Knowledge about Handwashing with Soap (CTPS) in the Intervention and Control Groups between Pre-Test and Post-Test

The results of statistical tests explain that health education with puzzle media has a significant influence on students' knowledge about Handwashing with Soap (CTPS) at SDN X Loa Janan Ilir. The results of this study are in line with a study that stated that puzzle play therapy has an effect on increasing students' knowledge about hand washing with soap (Hikmah, 2019). This is also in line with research that states that knowledge about handwashing practices of children in elementary schools increased after the implementation of health education (Habib, Hussain, Parveen, & Afzal, 2019).

According to the researcher's assumption, the effect of health education with puzzle media on student knowledge in the intervention group can occur because respondents in the intervention group receive specific information exposure provided by the researchers. In the intervention group, researchers conducted health education through the play method using puzzle media. When playing puzzles, students focus on rearranging the parts of the picture; they will be challenged and want to finish it. When students assemble the handwashing puzzle, they will be exposed to information about handwashing with soap repeatedly so that they will automatically memorize the steps in the six steps of how to wash hands properly and correctly.

The results of statistical tests explain that health education with PowerPoint slide media does not have a significant effect on students' knowledge about Handwashing with Soap (CTPS) at SDN Y Loa Janan Ilir. The results of this study are in line with a

study that stated that there is no significant difference that play therapy without using puzzles can increase knowledge about good handwashing in elementary school students at SDN Taman Sukaria 1 Tangerang City in the control group (Hikmah, 2019). Knowledge is the result of human sensing, or a person's understanding of objects through the use of their senses such as eyes, nose, ears, and so on.

How to gain knowledge can be obtained through health education. The success of health education for students depends on the learning component. Media in health education has an important role in health education activities (Hendriani, Chifdillah, & Tamara, 2019). According to the researcher's assumption, the absence of the effect of health education with PowerPoint slides on student knowledge in the control group could occur because respondents in the control group did not receive specific information exposure provided by the researchers.

In the control group, researchers only conducted health education through the lecture method using slide PowerPoint media, which made students feel uninterested, so slide PowerPoint media had no effect on the knowledge of these students.

Picture 1. Puzzle Media

Effect of Health Education on Handwashing with Soap (CTPS) Skills in the Intervention and Control Groups between Pre-Test and Post-Test

Students' abilities in the area of Handwashing with Soap (CTPS) at SDN X Loa Janan Ilir improved significantly after receiving health education via puzzle media, as shown by the results of the statistical test. This research confirms previous findings from Taman Sukari 1 Elementary School in Tangerang City that puzzles can enhance students' cognitive abilities. Skills improved significantly more after puzzle play therapy was implemented with the intervention group than they had been before (Hikmah, 2019). The results of this study are also similar to research that stated that health education about handwashing with the picture story method can have an impact on

handwashing skills using soap in preschool children at TK Alam Hijau Daun (Ahmad, Nikmah, & Putri, 2019).

According to the researcher's assumption, when playing puzzles, children will be taught to think creatively by arranging pieces of images. Puzzles can improve children's memory skills because the puzzle contains a sequence of handwashing steps. Good knowledge can be an asset to being able to apply good and correct handwashing with soap steps. In the intervention group, students were skilled in performing handwashing with soap steps because they had been able to put their knowledge about handwashing with soap into action.

The results of the statistical test explain that health education with PowerPoint slide media does not have a significant effect on student skills regarding handwashing with soap (CTPS) at SDN Y Loa Janan Ilir. The results of this study are in line with research, which shows that there is no significant difference that play therapy without puzzles can improve good handwashing skills in elementary school students at SDN Taman Sukaria 1 Tangerang City in the control group (Hikmah, 2019). The same thing was also in line with a study that stated that in the control group, there was no increase in handwashing behavior with soap, with 24 respondents who remained classified as a poor category (Dewi et al., 2019).

According to the researcher's assumption, the absence of the effect of health education with PowerPoint slide media on respondents' skills can occur because respondents in the control group did not receive specific information exposure provided by the researchers. Poor knowledge about CTPS makes students unskilled in performing good and correct handwashing steps. Therefore, it is important to provide health education to children using puzzle media. Puzzle media can improve children's handwashing skills because puzzle media, which is basically an educational game, will be more accepted by elementary school children because the information provided while playing while learning will be easily absorbed by children.

Differences in Knowledge of Handwashing with Soap (CTPS) in the Intervention and Control Groups After the Intervention

The study found that health education led to significant differences in participants' understanding of the importance of washing hands with soap after being administered to the intervention group compared to the control group. Consistent with previous findings, this study found that post-intervention knowledge scores were significantly higher for the intervention group compared to the control group on average (Hikmah, 2019). Children at elementary school age are generally more interested in the concept of learning while playing or edutainment. The concept of education prioritises the role of children as the main focus in the learning process and also as the subject of education itself.

The aim is to create a supportive and fun learning environment (Chifdillah & Rahayu, 2022). According to the researcher's assumption, the difference in the category of student knowledge between the control group and the intervention group was due to the different treatments applied to the two groups. Providing health education using puzzle media to the intervention group was able to increase children's knowledge about how to wash their hands properly. The use of puzzle media is effective because it is relevant to the concept of education.

Puzzle media, which is basically a game, will be more accepted by elementary school children because playing while learning will be easily absorbed by them. The

knowledge about handwashing with soap that children have makes them realise the importance of this action. This awareness encourages children to try and apply the steps of washing hands with soap that are good and correct in their daily activities.

Differences in Handwashing with Soap (CTPS) Skills in the Intervention and Control Groups After the Intervention

The study found that the intervention group improved their handwashing skills with soap more than the control group did after receiving health education. This study's findings are in line with those of other studies showing that puzzle play therapy leads to statistically significant improvements in children's skill levels compared to those of the control group (Hikmah, 2019). The researchers hypothesised that the media types employed for health education might account for the difference in skill levels between the intervention and control groups.

Students in the control group were uninterested in health education because it was delivered through a lecture format utilising PowerPoint presentations. Students in the intervention group received health education through a game-based approach with the help of puzzle-based media, in which they did not feel like they were learning. Students in the intervention group learnt more about the importance of hand hygiene and how to properly perform these tasks than those in the control group.

Future researchers are expected to increase the number of research samples, because in this study only 5th grade students were sampled. Future researchers may also change the intervention procedure. Future researchers can print more puzzle media because in this study the researchers did not print puzzle media according to the number of respondents, so when playing puzzles the respondents were divided into several small groups according to the number of puzzles available.

This study is expected to provide input to the Trauma Center health center to conduct health education about CTPS using puzzle media to elementary school students so that it can reduce the number of diarrhea cases in the area. In this study, it can be concluded that students at SDN X Loa Janan Ilir were affected by the existence of health education delivered through puzzle media, both before and after getting health education.

CONCLUSION

The findings of this study indicate that students at SDN X Loa Janan Ilir were influenced by the health education delivered through the puzzle media, both before and after receiving this health education. There were only two variables in this study, namely the knowledge variable and the skill variable, so the researchers could not see the development of attitudes and behavior toward Hand Washing with Soap (CTPS) in elementary school students. In addition, the researchers did not print the puzzle media according to the number of respondents, so when playing the puzzle, the respondents were divided into several small groups according to the total puzzles available. Future researchers can develop research variables such as attitude and behavior. In addition, further researchers can also print a more significant number of puzzles when conducting health education.

ACKNOWLEDGEMENT
We thank the principals of SDN X Loa Janan Ilir and SDN Y Loa Janan Ilir, along with all the teachers and staff, for allowing and accepting us to do research at these schools. In addition, we also appreciate all the students who participated in this study.

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