EFFECTIVENESS OF EDUCATIONAL GAME AS MEDIA GLOBAL WARMING MITIGATION ON ELEMENTARY STUDENTS IN YOGYAKARTA CITY

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Mitigation of global warming can be done with go green behavior. The establishment of go green behavior from childhood will be more effective. One of the factors that influence the behavior is knowledge. The purpose of this research: 1. Analysing the elementary school curriculum that related to global warming. 2. Designing and testing the effectiveness an educational games with the theme of global warming. 3. Analysing the perception of Elementary School students to educational games. This research used quantitative experimental method. The subjects were students 5A-B class Tegalrejo 3 and students 6A-B class Terbansari 1 Elementary School. Analysis of hypotheses using Mann Whitney and Wilcoxon test.

The result of subjects observation is known that global warming knowladge has not been presented holistically and in curriculum 2006, more global warming knowladge diffusion at the Natural Science and Indonesian Language subjects. Results of the validation of educational games shows that games can be applied to the Elementary School students. Hypothesis test results showed that educational game are effective because there is a significant difference in the improvement of knowledge between the experimental group and control group, it's influenced by gaming strategy factor that is of interest, concentration, retention, and emotion. All of research subjects (100%) feel their knowledge into increased global warming and increasingly motivated in protecting the environment. In conclusion although in formal education matter global warming on Elementary School inadequate but through educational game, global warming knowledge can be increased.

Keywords: Global warming, Mitigation, Educative game, Primary School students, Effectiveness

INTRODUCTION

Global warming is the event of the increasing average temperature in the atmosphere, sea, and the surface of the earth (Shodiq, 2013). The continuous temperature rise will cause climate change and generates a lot

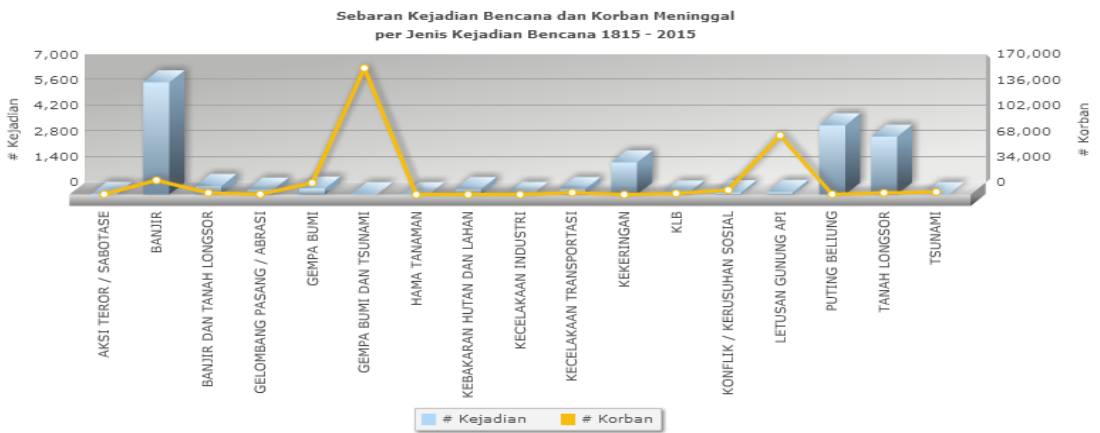of disasters (Sudibyakto, 2011). The amount of disaster occurrence in Indonesia can be seen on Figure 1.

Figure 1 The Distribution of Disaster Events in Indonesia
Source: BNPB (2015)

The global warming issue is rooted from the human perception towards their environment (Keraf, 2010). Various environmental damages that become the cause of global warming are the proof of the human behavior that tends to not pay attention to the balance of the nature (Sukmana, 2003). The global warming risk can be suppressed with environmental friendly behavior on daily life (Daniel, 2009). Accustoming and shaping new behaviors on adults are not as easy as on children (Mustaqim dan Wahib, 1991). The environmentally friendly behavior shaping since childhood will be more effective (Nicholson-Cole, 2005). Keraf (2010) stated that one of the factors that influences the perception and behavior is knowledge. According to Mustaqim dan Wahib (1991) based on the degree of cognitive development for children of age between 6-12 years which shows towards the reality, then lessons should be given with visual aid instruments as one of the example is through educative games. As the 3 priority in the *Hyogo Framework* which states that through knowledge, innovation, and education to build the save and strong culture on all educational units. This PRB needs to be the priority program on educational sector which is embodied in the PRB education at school (Gugus Tugas Pengarusutamaan PRB dalam Sistem Pendidikan Nasional, 2010).

The problems in this study are 1. How much global warming knowledge provided on the elementary lever studies, 2. Can the knowledge of global warming on elementary students increased through educational game method, 3. Do elementary students like the method of learning global warming through the educative game media. The

purposes of this study are 1. To analyze the elementary curriculum related to global warming materials, 2. To design some global-warming-themed educative games and test the effectiveness of the educative games, 3. To analyze the perception of elementary students towards educative games. Some of the benefits of this study are 1 As the media of educative game to increase the knowledge of global warming as mitigation attempts for elementary students, 2 As an alternative media on global warming mitigation.
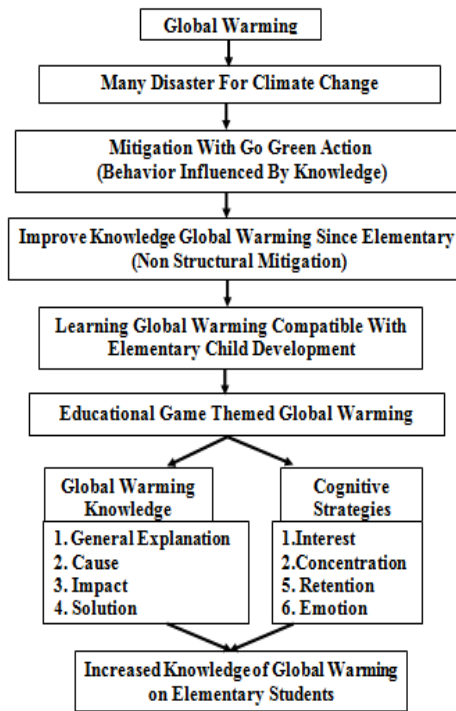
Theoretical Framework And Hypothesis

Figure 2 Theoretical Framework

Hypothesis (H_1) :
1. There is a significant difference in the improvement of knowledge between the experimental group and control group.
2. Increased knowledge of global warming in the experimental group was higher than the increase of knowledge in the control group.

Methods

This study used the quantitative approach with the experimental pretest–posttest control group design research plan. The location of this

study is assigned in Yogyakarta city because this city has the high rank for Environmental Quality Index for the Java island category and a high Index of Human Development for the DIY category. From random results, the corresponding Elementary Cchools in this study are Badran School, Tegalrejo 3 School, and Terbansari 1 School, shown on Figure 3.
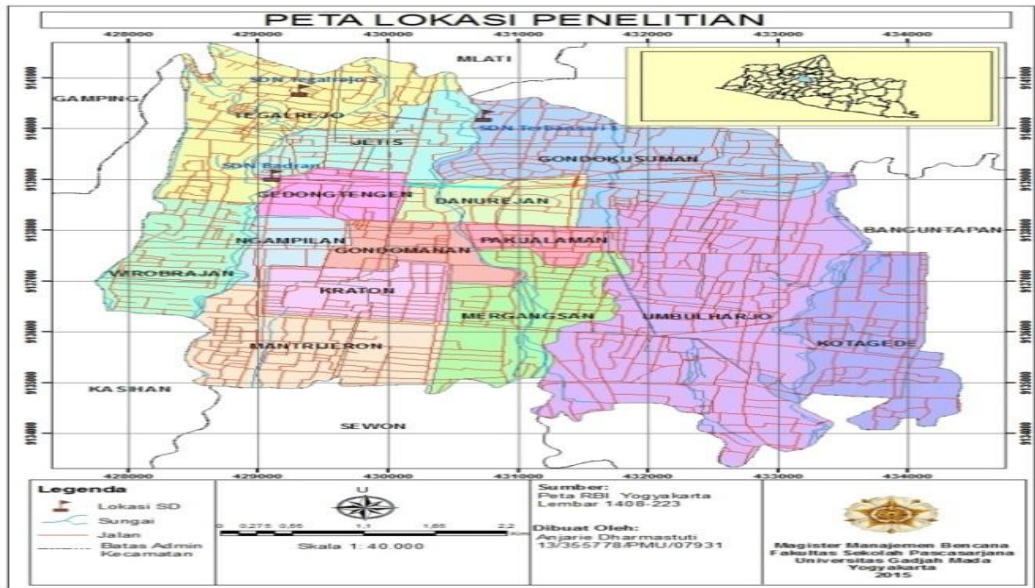

Figure 3 Map of the location of research

The school samples are taken based on the public elementary school besides Sobat Bumi, Siaga Bencana, Adiwiyata, and Inklusi, later on the school has to possess average level of achievement based on the 2014 National Examination. The time of the study was conducted on the beginning of June 2015. The instruments used includes 1 perception sheet, 2 validation questionnaire, 3 educative game media, 4 knowledge test questions, 5 perception sheet. The variable descriptions in this study are shown in Table 1 and Table 2.

Table 1 Derived Variable Of Educational Games

Variable	Sub Variable	Indicator	Descriptor
Educational Game Strategy	Interest	Display	Colorful designs and lot og image
		Equipment	Dice, pawns, cards, trees-money
	Concentration	Setting	Indoor
		Small Group	2-5 Student
		Column speech	Column with citation ("...")
	Retention	Repetation	Nothing finish column
		Pronunciation	Reading Card
		Recitation	Adipura Card
	Emotion	Competition	The number of trees
		Reward & Punishment	Fines trees & gifts tree

Table 2 Derived Variable Knowledge Of Global Warming

| Variable	Sub Variable	Indicator	Descriptor	Trial Item	Fix Item
	General explanation	Global Warming	Definition of global warming	2,7	1,5
	Cause	Greenhouse gas	Definition & kinds of Greenhouse gas	3,4,5, 32,35	2,3, 23, 26
	Impact	Climate Change	Floods, droughts, storms, disease	1, 6,8, 36,38,3 9	4,6,28,29
Knowledge of global warming			Reforestation and preserving trees	16, 17,18	11,12
		Carbon dioxside	Saving fuel	12,13, 15, 22, 29,	8,9,16,21
	Solution		Using environmentally friendly fuel	14	10
			Saving electricity Energy	10, 26	19,
			Using energy saving lamps	11	7
		Carbon monoxide	Not smoke	31	22
			Reduce and don't burn anorganic waste	9, 21, 23,24,2 5, 30	15,17,18,
		Freon	priority to the fresh air of the use of air conditioning	34	25
			Using AC with a minimum temperature of $25^{0}C$	33	24
		Methane	Reducing meat consumption	40	30
			Making biogas	37	27
			Waste sorting	19	13
			Processing organic waste into compost	20, 27, 28	14,20

The research steps are shown in Figure 4.
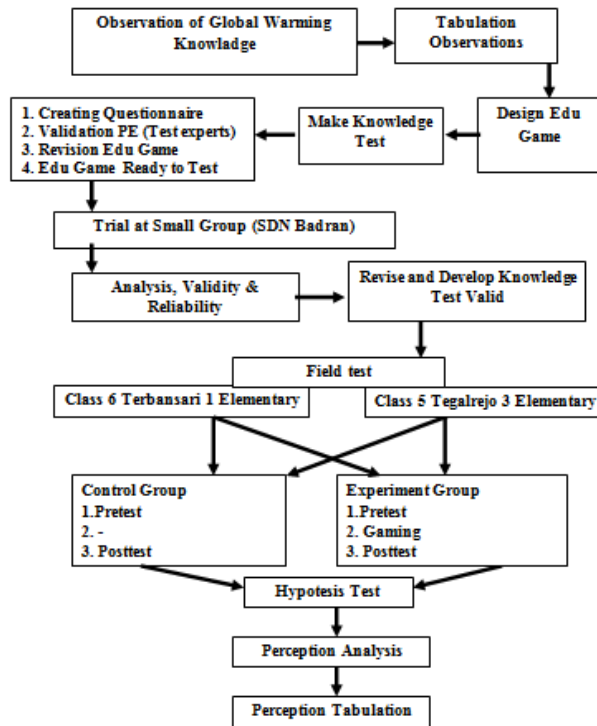
Figure 4 The Research Steps

The validity test used *Product Moment* with SPSS and the 0.30 validity standard value then from 40 items, this study achieved 30 valid

items. Based on the *Alpha Cronbach* reliability test, reliability item of 0,845 obtained, which means the reliability is very high. The hypothesis was conducted using non parametrical statistics which is the *U Mann-Whitney* test and *Wilcoxon* test.

RESULT
4.1 Knowladge Of Global Warming at The Elementary School Subjects

The subject observational results based on the 2006 curriculum which are infused with environmental material related to global warming was given the check sign (√) on Table 3.

Table 3 The Result Of Observations 2006 Curriculum Subjects

Mata Pelajaran	Kelas					
	1	2	3	4	5	6
BI	√	√	√	√	√	√
PKN	√	√		√		
IPA	√	√	√	√	√	√
IPS			√	√		√
PAI	√		√			
PAK		√	√			

The subject observational results based on the 2013 curriculum which are infused with environmental material related to global warming was given the check sign (√) on Table 4.

Table 4 The Result Of Observations 2013 Curriculum Subjects

Kelas	Tematik										
	1	2	3	4	5	6	7	8	9	PAI	PAK
1						√		√		√	√
2					√	√	√			√	√
4		√	√				√			√	
5	√	√		√				√			

The conclusion of the observational results of the elementary curriculum subjects of the year 2006 and 2013, the environmental materials related to global warming are included enough in the subjects even though it is still not comprehensive and holistic enough. The global warming materials are more infused in the Natural Sciences and Indonesian Language subjects. Based on the study by Dewi (2014) it is known that the comprehension of middle school students related to global warming can still be considered minimum. Earlier knowledge

construction will help in shaping the character of human. Early global warming knowledge since childhood on students is very beneficial remembering that students are agents and communicators to spread the knowledge that they have received to the people around them (Gugus Tugas Pengarusutamaan PRB dalam Sistem Pendidikan Nasional, 2010).

Table 5 The Result Of Observations Non Curriculum

Sekolah	Non Kurikulum	
SDN Terbansari 1	-	-
SDN Tegalrejo 3	Pramuka	

The Observational results from the Non Curricular Activities in the corresponding schools are provided in Table 5. The addition of environmental studies outside of the curriculum is inadequate, in SDN Tegalrejo 3 were just given through Scout (Pramuka) where the environmental materials are not directly aiming to global warming.

4.2 The Development and Effectiveness of the Global Educational Games

The test results by the Psychological Lecturer on educative game has obtained 100% valid results and can be used without revision when observed from the psychological development of elementary students. The material tests in educative game conducted by 2 Elementary Teachers and an Environmental Lecturer resulted 2.5% can be used with a little revision and 97.5% can be used without revision.

Referring to the media development phase according to Sadiman et al (2002), therefore the phases of the educative game development in this study consisted of:

1. The need analysis phase. The younger generation needs to be given some environmental education related to global warming, so they can act real accordingly.
2. The material selections. The materials used to make the educative game are made from relatively environmentally friendly objects such as thick cardboards which are usually made from recycled materials.
3. The material formulation. The inserted material components are shown on Table 2. This material formulation is also accompanied with the game strategy design as presented on Tabel 1.
4. The development of game measuring instruments. The game effectiveness measuring instruments in increasing the global warming knowledge are made with knowledge tests in multiple choice form.
5. The game creation. The image design of the game were made using the MS.

6. Word and Corel Draw for windows. The font type used was Comic Sans MS.

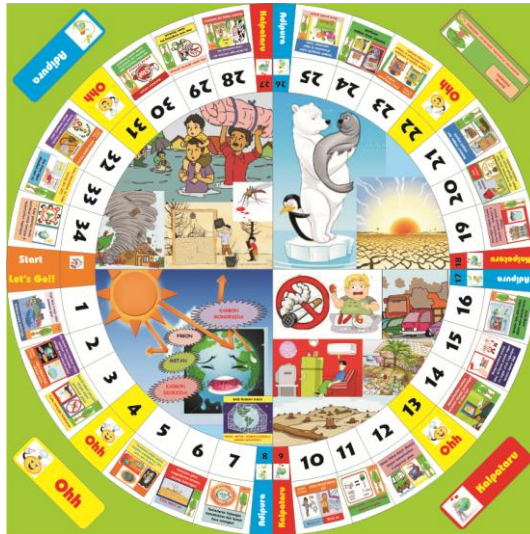The educative game models can be seen on Figure 5.

Figure 5 Image Of Educational Game

The materials of the educative games are 4 thick cardboards sized 28x28, 4 sheets of A3 Ivory papers and some colorful duct tapes. Some of the game equipments can be seen on Figure 6-10.

Figure 6 Game Equipment (money tree, pawns and dice)

Figure 7 Zone Certificate

Figure 8 Adipura Card

Figure 9 Kalpataru Card

Figure 10 Ohh Card

7. The evaluation phase. The evaluation in this study was conducted with game test in SDN Badran Yogyakarta city. The evaluation was also conducted by some validators.

8. The revision phase. The measuring instruments that was initially consisted of 40 items become 30 ready-to-use items after being validated.

At Table 6 and 7 Field Test Result Of The Experimental Group Terbansari 1 Primary School.

Table 6 Field Test Result Of The Experimental Group Terbansari 1

Class 6A Terbansari 1 Primary School (Experimental Group)							
Student	Pretest	Posttest	Description	Student	Pretest	Posttest	Description
1	11	20	Increased	14	10	21	Increased
2	13	27	Increased	15	13	25	Increased
3	9	19	Increased	16	18	26	Increased
4	11	23	Increased	17	24	30	Increased
5	18	28	Increased	18	16	27	Increased
6	12	22	Increased	19	13	25	Increased
7	10	21	Increased	20	15	24	Increased
8	14	25	Increased	21	18	30	Increased
9	11	20	Increased	22	11	25	Increased
10	17	25	Increased	23	20	30	Increased
11	15	27	Increased	24	17	29	Increased
12	14	25	Increased	25	14	23	Increased
13	12	21	Increased	26	12	25	Increased

experienced score escalation from pretest to posttest.

Table 7 Field Test Result Of The Control Group Terbansari 1

Class 6B Terbansari 1 Primary School (Control Group)							
Student	Pretest	Posttest	Description	Student	Pretest	Posttest	Description
1	16	18	Increased	14	13	12	Decreased
2	19	20	Increased	15	13	15	Decreased
3	14	16	Increased	16	12	8	Decreased
4	12	13	Increased	17	21	21	Increased
5	15	12	Decreased	18	13	12	Decreased
6	19	20	Increased	19	15	17	Increased
7	8	11	Increased	20	11	12	Increased
8	11	10	Decreased	21	10	13	Increased
9	11	13	Increased	22	24	25	Increased
10	16	15	Decreased	23	22	20	Decreased
11	12	11	Decreased	24	13	11	Decreased
12	10	8	Decreased	25	11	13	Increased
13	11	9	Decreased	26	13	15	Increased

Based on Table 7 it can be concluded that the score increased from pretest to posttest as many as 13 students, the score declined for 12 students and no score changes on 1 student.

Table 8 Mann Whitney Result Of The Terbansari 1 Primary School

Test Statistics^a

	postes
Mann-Whitney U	24,000
Wilcoxon W	375,000
Z	-5,765
Asymp. Sig. (2-tailed)	,000

a. Grouping Variable: subyek

The posttest results between the experimental and controlled groups used the *Mann Whitney* test as presented on Table shows results as the follows: $0.000 < 0.05$, so H_0 rejected and H_1 accepted. It means that there were significantly different knowledge scores between the experimental and controlled group.

Table 9 Wilcoxon Test Result Of The Experimental Group Terbansari 1

	postes.kel.eksperimen - pretes.kel.eksperimen
Z	$-4,473^b$
Asymp. Sig. (2-tailed)	,001

From the *Wilcoxon* hypothesis test on the controlled group as presented on Table 9 the results are $0.001 < 0.05$, therefore H_0 rejected and H_1 accepted. There are some significant increases of knowledge from pretest to posttest on the experimental group.

Table 10 Wilcoxon Test Result Of The Control Group Terbansari 1

Test Statistics^a

	postes.kel. kontrol – pretes.kel. kontrol
Z	$-,630^b$
Asymp. Sig. (2-tailed)	,529

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

From the *Wilcoxon* hypothesis test on the controlled group as presented on Table 10 the results: $0.529 > 0.05$, therefore H_0 accepted and H_1 rejected. There was no significant knowledge increase from pretest to posttest on the controlled group.

At Table 11 and 12 will be presented the results of field tests in Tegalrejo 3 Primary School.

Table 11 Field Test Result Of The Control Group Tegalrejo 3

Class 5A Tegalrejo 3 Primary School (Control Group)							
Student	Pretest	Posttest	Description	Student	Pretest	Posttest	Description
1	12	14	Increased	13	12	11	Decreased
2	10	11	Increased	14	9	12	Increased
3	7	9	Increased	15	13	12	Decreased
4	15	14	Decreased	16	21	23	Increased
5	9	10	Increased	17	13	9	Decreased
6	13	11	Decreased	18	8	12	Increased
7	11	10	Decreased	19	12	12	Stable
8	16	15	Decreased	20	14	13	Decreased
9	10	12	Increased	21	17	15	Decreased
10	12	11	Decreased	22	13	14	Increased
11	14	13	Decreased	23	18	17	Decreased
12	8	9	Increased	24	11	12	Increased

Based on the Table 11 it can be concluded that there are increases from pretest to posttest as many as 11 students, decline for 12 students, and no changes for 1 student.

Table 12 Field Test Result Of The Experimental Group Tegalrejo 3

Class 5B Tegalrejo 3 Primary School (Experimental Group)							
Student	Pretest	Posttest	Description	Student	Pretest	Posttest	Description
1	14	25	Increased	14	9	19	Increased
2	11	18	Increased	15	11	20	Increased
3	14	29	Increased	16	20	30	Increased
4	10	20	Increased	17	13	27	Increased
5	11	15	Increased	18	7	19	Increased
6	6	16	Increased	19	15	23	Increased
7	12	24	Increased	20	10	17	Increased
8	10	21	Increased	21	12	23	Increased
9	19	30	Increased	22	8	19	Increased
10	16	25	Increased	23	11	25	Increased
11	10	22	Increased	24	14	27	Increased
12	8	16	Increased	25	11	24	Increased
13	12	25	Increased				

Based on Table 12 it can be concluded that all of the 25 students or 100% of the subjects experienced score increasing from pretest to posttest. The highest score increase was 15 points and the lowest was 7 points.

Table 13 Mann Whitney Test Result Of The Tegalrejo 3 Primary School

Test Statistics[a]

	postes
Mann-Whitney U	17,500
Wilcoxon W	317,500
Z	-5,662
Asymp. Sig. (2-tailed)	,000

a. Grouping Variable: subyek

The results scores of the posttests between the experimental groups and the controlled group with the *Mann Whitney* test as presented on Table 13 shows the results as follows $0.000 < 0.05$, therefore H_0 rejected and H_1 accepted. It means that there are some significant differences between the experimental group and the controlled group.

Table 14 Wilcoxon Test Result Of The Control Group Tegalrejo 3

	postes.kel. kontrol – pretes.kel. kontrol
Z	-,407[b]
Asymp. Sig. (2-tailed)	,684

From the *Wilcoxon* test on the controlled group as presented on Table 14 the results obtained were $0.684 > 0.05$, therefore H_1 rejected. There were no significant knowledge increases from the pretest to posttest on the controlled group.

Table 15 Wilcoxon Test Result Of The Experimental Group Tegalrejo 3

	postes.kel.eksperimen - pretes.kel.eksperimen
Z	-4,394[b]
Asymp. Sig. (2-tailed)	,008

From the *Wilcoxon* hypothesis test on the experimental group as presented on Tabel 15 the results obtained were $0.008 < 0.05$, therefore H_0 rejected and H_1 accepted. There were some significant knowledge increases from pretest to posttest on the experimental group.

The success on the experimental group is not separated from the applied strategy in the games which includes interests strategy, concentration, retention, and emotion. Through the educative games media format surely it is easy to arouse interest in children. This matter is in accordance with what Mustaqim and Wahib (1991) stated that interest can push children to learn and try new things. The global warming information in these educative games can be absorbed well surely are not separated from the existence of the concentration strategy. The strategy such as the setting which aims to minimize the noises from outside. The

amount of players were not too many such as 2-5 kids. The statement box that has quotation marks made the players has to be alert all of the time, this is in accordance with what Winkel (1996) stated that the unexpected stimulations makes the senses are more ready to focus. The global warming knowledge absorption from these games are further helped with the presence of the memory strategy that is through memorizing the Adipura Cards. According to Winkel (1996) the processed and stored information in audio visual form will be better extracted from the long term memory. The presence of fine and rewards are one of the form of emotional strategy. Everything that touches the emotion certainly are easier to remember again as stated by Yusuf (2009) that emotion is a dominant factor that influences the learning process. Based on the studies by Nadji and Sheikh (2012), the educative games are very good instruments to increase the learning skills and help children to achieve maximum results from the learning process.

4.3 The Elementary Student Perception Towards Global Warming Themed Educative Games

Table 16 Summary From Results Of Students' Perceptions

Kelompok Eksperimen SDN Terbansari 1	Kelompok Kontrol SDN Terbansari 1	Kelompok Eksperimen SDN Tegalrejo 3	Kelompok Kontrol SDN Tegalrejo 3
96.15% of the students have not known about global warming.	92.30 % of the students have not known about global warming.	87.50% of the students have not known about global warming.	92 % of the students have not known about global warming.
84.61% of the students have not played any games like this before.	76.92 % of the students have not played any games like this before.	79.16 % of the students have not played any games like this before.	72 % of the students have not played any games like this before.
100 % of the students agreed that these games were interesting.	100% of the students agreed that these games were interesting.	100% of the students agreed that these games were interesting.	100 % of the students agreed that these games were interesting.
100 % of the students want to play these games again.	100% of the students want to play these games again.	100% of the students want to play these games again.	100 % of the students want to play these games again.
92.30% of the students agreed that the games were easy.	88.46% of the students agreed that the games were easy.	87.50% of the students agreed that the games were easy.	92 % of the students agreed that the games were easy.
100 % of the students felt happy	96.15% of the students felt happy	100 % of the students felt happy	100 % of the students felt happy

to play the games with their friends.	to play the games with their friends.	to play the games with their friends.	to play the games with their friends.
96.15 % of the students felt that the sentences in the games are easy to understand.	84.61% of the students felt that the sentences in the games are easy to understand.	91.66% of the students felt that the sentences in the games are easy to understand.	96 % of the students felt that the sentences in the games are easy to understand.
96.15 % of the students felt that they understand more about global warming after playing the games.	92.30 % of the students felt that they understand more about global warming after playing the games.	95.83% of the students felt that they understand more about global warming after playing the games.	88% of the students felt that they understand more about global warming after playing the games.
100 % of the students felt that they were motivated to take care of the environment after playing the games.	100 % of the students felt that they were motivated to take care of the environment after playing the games.	100% of the students felt that they were motivated to take care of the environment after playing the games.	100% of the students felt that they were motivated to take care of the environment after playing the games.
100 % of the students felt that the games can increase their knowledge about global warming.	100% of the students felt that the games can increase their knowledge about global warming.	100 % of the students felt that the games can increase their knowledge about global warming.	100% of the students felt that the games can increase their knowledge about global warming.

Based on the playing impression tabulation or the students' perception towards educative games, as presented on Table 16 it is known that 100% students from all groups whether in SDN Terbansari 1 as well as SDN Tegalrejo 3 felt that the knowledge relating to global warming increased. As studied by Arslan (2011) by using the *enviropoly* media, the result of this study also shows that motivating children to take care of the environment can be done through educative games media. The study by Taber and Taylor (2009) also showed that the knowledge increase about the environment tends to be followed by the increase of the environmental awarenessas well.

CONCLUSION
1. The learning curriculum in elementary schools in general has covered environmental materials but not focused yet on the global warming materials and not presented holistically especially the absence of the materials about greenhouse gasses. The subjects in the 2006 curriculum that carries the most materials relating to global warming are Natural Sciences and Indonesian Language.
2. Based on the evaluation results by the validators, the development of global warming themed educative games has been categorized as

worthy or suitable from the children psychological point of view and the global warming materials. The global warming themed educative games in this study are proven to be effective in increasing the global warming knowledge on elementary students. Some of the things that become the driving factors of why these educative games are effective are the presence of a few strategies such as the strategy of interest, concentration, retention, and emotions. The strategy plays an important role in helping the students to absorb the global warming materials in the games. The effectiveness of these educative games were proven through the significant score differences between the experimental group and the controlled group. The Mean posttest score on the experimental group whether in SDN Terbansari 1 as well as in SDN Tegalrejo 3 are far higher than the controlled group.
3. After playing these educative games, 100% of the study subjects felt that these games were interesting, their global warming knowledge increased, and they were motivated to take care of the environment. The motivated children to take care of the environment are not separated from the application of the emotional strategy in the games.

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