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EFFECTIVENESS OF GAME MODEL ON TSUNAMI DISASTER ANTICIPATION IN TWO PROVINCES OF INDONESIA, YEAR 2019

Widiastuti[1,a], Siswo Poerwanto[2,b], Hernawan[3,c] , B.Firdiansyah[4,d], Sugiharto[5,e]

[1, 3, 4] Sports Education, Postgraduate Jakarta State University, Indonesia

[2, 5]University of Binawan, Jakarta, Indonesia

[a]widiastuti@unj.ac.id , [b]spoerwanto2006@gmail.com (Corresponding author), [c]hernawan@unj.ac.id

[d]Bahtiarfirdiansyah_por17s2@mahasiswa.unj.ac.id . [e]sugiharto@binawan.ac.id

ABSTRACT

Indonesia is an archipelagic country prone to natural disasters, especially tsunami as the one that hit the Aceh Province in 2004 - which caused over 80,000 deaths and 125.000 injuries including elementary school children. A school preparedness survey in Indonesia indicated that among school-age children aged 7-12 years, their knowledge and preparedness in disaster emergencies was low. Consequently, dealing with disaster management, the government of Indonesia became responsible in determining the best strategies in building up preparedness. Given the existing problems, the present study aimed at developing and evaluating the effectiveness of the Game Model of Knowledge and Physical Fitness among Elementary School Children in Tsunami Disaster Anticipation for six tsunami-affected schools in Banten and W. Sumatra Provinces. The intervention study applied qualitative and quantitative approaches to develop and evaluate the effectiveness of the game model. Qualitative data was obtained from observations, interviews and secondary data documentation. The quantitative data obtained from the sample of 240 students was analyzed in accordance with the study objective. SPSS trial version 17 was used for the analysis. The results of paired and independent t-test on knowledge and fitness of the students showed that the model was effective. The effectiveness of the model in terms of improved scores was better among the intervention group than the control ($p < 0.05$), even though significant

improvement was also observed among the control. In conclusion, the policy implication suggested that the model may be applied and disseminated in other tsunami vulnerable areas in other provinces of Indonesia.

Keywords: *Tsunami disaster management, effectiveness, game model, elementary school students.*

1. INTRODUCTION

Indonesia is an archipelagic country prone to natural disaster, especially tsunamis generated by volcanic eruptions and earthquakes, resulting by collisions of three active tectonic plates which surround Indonesia. These are the Euro-Asian, the Indo-Australian, as well as the Philippine and the Pacific Ocean plates in the East, north, and south. Therefore Indonesia has high vulnerability to natural disasters such as volcanic eruptions, earthquakes and tsunamis (Anam et al. 2018). Data from the 2015-2019 National Disaster Management Agency showed that Indonesia was hit several times by tsunamis from 1818 to 2014 (Renas, 2014). In 2004, the Aceh province was hit by the biggest tsunami ever recorded, which resulted in over 80,000 deaths and 125.00 injuries, which including elementary school children. It was the fifth largest disaster in world history, after the 1964 Alaskan earthquake and tsunami (Fitriawan, 2017). In accordance with the Indonesian Law Number 24 of 2007 concerning Disaster Management, the government is responsible for preparing the best strategies related to disaster relief efforts in the country. In building preparedness, knowledge and understanding of disaster phenomena in general, are very important for the formal education of students. Consequently, after the 2004 earthquake and tsunami, in order to reduce the risk of tsunami disasters in Indonesia the government formed a Tsunami Warning System under the name of "Indonesian Tsunami Early Warning System" (Anam et al. 2018). It was obvious that tsunamis and natural disasters in general, have posed a social burden not only on the government but also on the communities.

The need to create a model that involves a learning process to enhance knowledge of tsunami disaster anticipation and of improving physical fitness of elementary school students has been supported by results of various studies. Research evidence from Malaysia showed that learning with new knowledge must include cultivating the value of a positive attitude, without leaving physical activity in order to stay fit, and able to continue the learning process (Horikawa and Shuto 2010). Results of research conducted by Stough and Sungyoon (Stough and Sungyoon 2018) stressed the importance of safety practices facing global disasters in schools for children by providing knowledge of emergency natural disaster procedures and not accompanied by actual action. A study by Hidayati (2016) proves that pusijump (Puzzle, Music and Magic) learning methods are effectively used in earthquake and tsunami disaster preparedness learning intended for mild mentally retarded students, While Burhany and Tendy (2016) found that discussing risk reduction in tsunami disasters is more suitable to be carried out by debriefing knowledge about anticipating the tsunami disaster. They stated that to reduce the number of fatalities due to natural disasters, one of the efforts is to provide knowledge in the form of information and of anticipated needed actions.

Students or school-age children are the most vulnerable population, and yet play an important role in disaster preparedness, both at home and school (Anam et al. 2018). Children must have knowledge about human behavior and the risks caused by natural disasters, especially tsunamis (Suppasri et al. 2016), (Seneviratne, Amaratunga and Pathirage 2010). However, only a small number of students understand the preparedness that is needed for natural disasters, particularly of tsunamis (Kongko and Hidayat 2014). Survey data on school preparedness in facing disasters in Indonesia is lacking. Of 55 school children between 7 to 12 years old, 20% recognized the existence of the natural disaster early warning system, 13.3% of them had the ability to know emergency preparedness plans and 10.6% had skills in natural disaster emergency alert simulation (Syarif and Irawan 2015).

In addition, physical activity of children with appropriate training will benefit their cognitive abilities as well as their academic performance. Thus, participation of children in disaster simulation exercises not only involve cognitive intelligence, and are enhanced by their physical fitness. In brief, skills in tsunami alert emergency simulations involve cognitive knowledge, and physical fitness, both being prerequisites for success of the simulation game. The physical fitness component consists of various activities such as running, jumping, crawling, jogging, squatting, push ups, sit ups, and other motor movements aimed at increasing physical fitness.

The government provides students with the knowledge and skills through a formal educational syllabus, aimed at improving cognitive abilities as well as skills in simulating emergency anticipation of a tsunami disaster. The school curriculum for physical education aimed at achieving graduates with competence, i.e., the core competence (KIs) consisting of four competencies. KI-1 on faith and religion, KI-2 on character and personality, KI-3 on knowledge and KI-4 on skills. In accord with the 2013 Curriculum for Physical Education for Elementary School year 9, namely, KD 4.1 to 4.3, it was explained that students practiced a combination of locomotor and non-locomotor basic motion patterns based on the concept of motion in various simple forms of play (Kemendikbud 2013). Simple games in this case can be realized with a variety of fun activities without a coercive voluntary concept. The concept of the game is suitable for use in learning for elementary school age children (Singer 2015). All is required in the anticipated tsunami disaster activities.

Up to now there was no research in the development of tsunami disaster anticipation methods for primary school-aged children in tsunami-affected prone areas, as well as testing its effectiveness in improving cognitive abilities along with increasing physical fitness levels simultaneously. Therefore, the aim of the present study was to develop a tsunami disaster anticipation model for learning physical education and tested for its effectiveness in improving cognitive abilities and physical fitness among elementary school students in the tsunami prone areas. The outcome of this development study is a game model of tsunami disaster anticipation for elementary school children in the vulnerable areas of tsunami disaster.

2. METHODS

The development study uses qualitative and quantitative approaches. The design for a model development adopted the ADDIE (Analysis, Design, Development, Implement and Evaluation) development step (Branch 2009) shown in Figure 1.

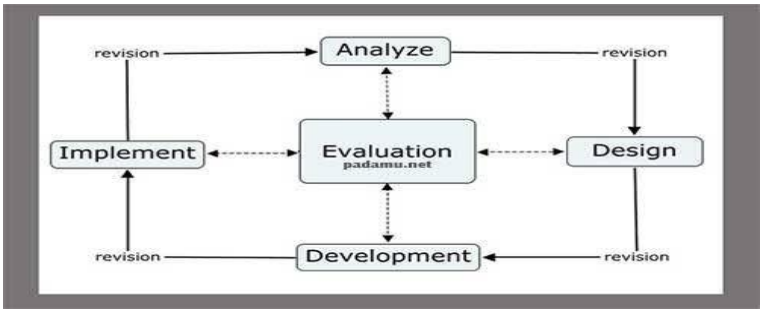

Figure 1. Steps to develop a model (Branch, 2009)

The study has been approved by the Ethical Committee of the Jakarta State University number 081/RE-PORS2/EC/III/2019 dated 6 March 2019. On behalf of the students, informed consent was given by their teacher after they understood the explanation given by the researchers. The simple random sampling was applied to obtain a sample from a population of elementary school children in 6 tsunami-affected schools in Banten and West Sumatra Provinces. There were 240 students randomly selected and consisted of 120 students assigned as the intervention group and 120 students was assigned as the comparison group. The intervention study design with two arms was implemented, in which the intervention group was compared with the control group. The intervention group received a developed model consisting of educational and learning module plus aerobic exercise, while the control group did not received development module but followed a conventional educational module given at the school. The aerobic exercise given was in aCcord with the 2013 Curriculum for physical education subjects in grade 3 elementary school, namely KD 4.1 to KD 4.3, whereas the knowledge-based educational and learning module was in addition to the existing standard module to achieve core competencies, namely KI-1 to KI-4. The KI-1 covers faith and religion, KI-2 covers character and personality, KI-3 covers knowledge and KI-4 covers skills.

Prior to the intervention, a qualitative approach was implemented and aimed to develop a model of game anticipation of a tsunami disaster. During the development phase, having done the initial needs analysis, the design of a model was developed and validated by a national natural disaster management expert, two regional disaster management experts, one sports sociologist and one physical education expert and sports game evaluation expert. In the developed model there are thirty items to be delivered to the intervention group, in which the items were based on the storyboard developed previously. The design consists of the items and objectives seen in **Annex 1**. As indicated elsewhere (Palar et al. 2015), a physical education learning process was an important element of the model and that the purpose of an exercise was to improve students' physical fitness by conducting one week of 2 to 3 meetings with an aerobic exercise duration of 60-90 minutes.

Annex 1. Objectives and 30 modules' item in the model of simulation game in anticipation of a tsunami disaster.

Objective 1: Understanding Preparedness and Anticipation Simulation

1/. Preparedness simulation in anticipation of a tsunami disaster	2/. Simulation looking for and heading to a safe place.	3/. Simulation of tsunami disaster preparedness with compact and
4/. Eliminate feelings of panic, anxiety and worry	5/. Simulation actions improve life safety during	

Objective 2: Understanding the simulation of tsunami early warning system activities

6/. Simulation of the tsunami early warning system according to tsunami disaster procedures	7/. Simulation of alertness and dexterity in the activities of the tsunami early warning system

Objective 3: Understanding and translating BPBD information related to anticipating a tsunami disaster

8/. Learn and understand the BPBD information and	9/. Implement the instructions of the Regional Disaster Management	10/. Learn the BPBD information and instructions

Objective 4: Understanding Evacuation Routes

11/. Understand the safe evacuation routes	12/. Finding someone else's safe evacuation	13/. Make a tsunami evacuation route

Objective 5: Understanding disaster foreign words

14/. Understanding of foreign words in anticipation of a	15/. Mention of foreign words in anticipation of the tsunami disaster	16/. Conduct activities from foreign words in anticipation of the

Objective 6: Understanding post-disaster activities

17/.Simple action simulation after the tsunami disaster	18/. Simulations avoid puddles, hazardous substances after the

Objective 7: The game that is applied contains the concept

19/. The process of learning physical education	20/. Active Motion	In groups
21/. Competition	22/. Aerobic Exercise	3 to 4 times @ 10-15 minutes

Objective 8: Improving Physical Fitness component

23/. Strength	24/. Muscle endurance	25/. Heart resistance
26/. Agility	27/. Speed	28/. Flexibility
29/. Balance	30/. Coordination	Action Reaction

The quantitative approach was implemented after the game model has been completed. The quantitative approach in terms of an intervention study was aimed at testing the model effectiveness through two outcome measures, namely, students' knowledge and physical fitness before and after the intervention for about one month. The outcome was compared among the two groups at the end of the intervention (post and post test), as well as before and after (pre and post test) for each group. To test the effectiveness of the model a paired t-test for both group during pre- and post-intervention period amongst intervention group on both students' knowledge and physical fitness, was used. In testing the physical fitness, the Indonesian Physical Fitness Test (TKJI) aged 10-12 years for Indonesian child standards was used, in which a composite standard score was used as a reference (see Table 1).

Table 1. Score of physical fitness in accord with TKJI (Indonesian Physical Fitness Test)

Composite Score	Classification
22 - 25	Very Good
18 - 21	Good
14 – 17	Moderate
10 – 13	Deficient
5 – 9	Poor

To test the knowledge score of the elementary school children, a questionnaire consisting of 18 questions in the model was evaluated to produce a composite score. The instrument was developed based on the indicators of tsunami early warning system and outdoor activity.The score was obtained from the test of knowledge on anticipation of tsunami disaster in the 18 questions with

multiple choice answers. The correct answer was scored 1, whereas wrong answer was scored 0. For each student the score range was from 0 to 18, and for each of either the intervention or control group, the score in percentage was obtained which was equal to [(correct answer/18) x 100].

3. RESULTS

As shown in Annex 1, out of 30 items that have been developed, as many as 28 items were implemented and another 2 were aborted due to limited infrastructure for implementation, and for inability of replacement by other games. The outcome of the model effectiveness was measured using both a composite knowledge score and a composite physical fitness score before and after intervention to intervention group only. To do the analysis, SPSS v.22 was used. Characteristics of the sample are shown in Table 2.

Table 2. Characteristics of the sample

Characteristics		Location				Total	
		Banten		West Sumatra			
		n	%	n	%	n	% row
Age	10 year	55	22,917	65	27,083	120	50
	11 year	61	25,417	59	24,583	120	50
Gender	Boy	49	20,417	71	29,583	120	50
	Girl	62	25,833	58	24,167	120	50
Knowledge Score	High	29	12,083	30	12,500	59	24.6
	Medium	47	19,583	67	27,917	114	47.5
	Low	32	13,333	35	14,583	67	27.9
Physical Fitness Score	Good	17	7,083	12	5,000	29	12.1
	Medium	97	40,417	82	34,167	179	74.6
	Poor	21	8,750	11	4,583	32	13.3
Group	Treatment	55	45,833	65	54,167	120	50
	Control	65	54,167	55	45,833	120	50

Before a paired t-test was conducted, normality test of Kolmogorov-Smirnov was performed before and after the intervention for both data on knowledge and physical fitness. All data showed a normal distribution, which made feasible the paired t-test being being conducted. Results of descriptive statistics and paired t-test on knowledge and physical fitness test are shown in Table 2 and Table 3, respectively as follows.

Table 3. Mean of knowledge and fitness score before (pre-) and after (post-) intervention among intervention and control students

Group	Module	Pre & Post	N	Mean	Std. Deviation	Std. Error Mean
Intervention	Pair 1 (Knowledge)	pre-IP	120	38,658	9,7079	,8862
		post-IP	120	78,188	9,8206	,8965
	Pair 2 (Fitness)	pre-IF	120	8,86	1,920	,175
		post-IF	120	17,18	1,986	,181
Control	**Pair 3 (Knowledge)**	pre-KP	120	40,878	9,5884	,8753
		post-KP	120	53,962	9,3413	,8527
	Pair 4 (Fitness)	pre-KF	120	8,95	1,454	,133
		post-KF	120	11,17	1,687	,154

KP : knowledge score among control group; IP : Knowledge score among trial group
KF : fitness score among control group; IF : Fitness score among trial group

It can be seen in Table 2 that the mean results of the pre-test and post-test knowledge of the anticipation of the tsunami disaster were 38,658 and 78,188. Meanwhile, as seen from Table 2 the average physical fitness composite score during pre- and post-intervention among the intervention group showed scores of 8.86 and 17.18, respectively. Merely looking at the scores classification as shown previously in Table 1, the intervention model resulted in a significant improvement from 'poor physical fitness'(range 5 – 9) to 'moderate physical fitness'(range 14 – 17) .

The results of paired t-test of knowledge and fitness score before and after intervention among intervention and control groups are shown in Table 3. On the knowledge score, the mean difference between pre and post intervention was 39.53 (37.11, 41.94) with statistic $t\text{-count}_{(df=119)}$ = 32,368 and p-value = 0,00 (or <0.05), indicating that there was a 95% significance level difference in the knowledge score of anticipating the tsunami disaster before and after being given the treatment of the model game. It is therefore concluded that the game model is effective and can increase the knowledge of tsunami disaster anticipation among elementary school children.

Meanwhile, on the physical fitness score the mean difference between pre and post test was 8,317 (7,843-8.791) with a $t\text{-count}_{(df=119)}$ = 34,749 and p-value = 0.00 (or <0.05) with significancy level of 95%. Hence, it is concluded that the game model in the form of exercise is effective and can increase significantly the physical fitness of tsunami disaster anticipation among intervened elementary school children through a physical education learning module significantly.

The next study questions to be answered were : 1). What was the results among the control group?; and 2). Given the results of post-test on knowledge test and physical physical fitness test among the intervention and control group, was the effectiveness of module given to the intervention group better than the control?

Looking back at the Table 2, it can be seen that among the control group the mean of the pretest and post-test knowledge of the anticipation of the tsunami disaster were 40,878 and 53,962 respectively. The average mean difference indicated that among the control students the knowledge on anticipation of tsunami disaster has increased significantly ($p < 0.05$), as seen in Table 3.The mean difference between pre and post intervention showed that was 13,083 (11,57, 14.59) with statistic $t\text{-count}_{(df=119)} = 17{,}175$ and p-value = 0,00 (or <0.05), indicating that there was a 95% significance level difference in the knowledge of anticipating the tsunami disaster before and after being given the treatment of the model game. It is therefore concluded that the game model is also effective and can increase the knowledge of tsunami disaster anticipation among control children. Compared with the intervention group, it was noted the improvement in the control group was worse than the intervention group, namely, 8,3 and 39,5 respectively.

Meanwhile, as seen from Table 2 the average physical fitness composite score during pre- and post-intervention among the intervention group showed scores of 8,95 and 11,17, respectively. Referring to the scores classification as shown previously in Table 1, the intervention model resulted in a slight improvement from 'poor physical fitness'(range 5 – 9) to 'deficient physical fitness'(range10 – 13) . The improvement was worse than that of the intervention group.

Overall, it is concluded that the applied exercise model can significantly improve the fitness level of primary school children through a physical education learning module within the game model. It also proves that the tsunami disaster anticipation among control students on physical education learning was also an effective effort to improve the physical fitness of control elementary school students who did not receive the module.

From Table 2 and Table 3, paired t-test indicated significant differences on both trial and control group on the knowledge and physical fitness score before and after intervention ($p < 0.05$). From these tables it was indicated that the increased score among trial group was higher than the control group.The knowledge of score difference after the trial period among intervention group was 50,56% as compared with 24.26% among the control group, indicating that the impact of the module given to the intervention group was greater than that of the control group. Similarly, the impact of the physical fitness module given to the intervention group was bigger than that of the control group, by as much as 49.63 points versus 19,87 point respectively. Given the above data, the hypothesis formulated that there was a significant larger increase on both knowledge and physical fitness score after the trial period among the intervention group than the that of the control group. To test the hypothesis the paired t-test was conducted. The results are presented in Table 4 and 5.

Table 4. Significancy level of pre- and posttest on knowledge and fitness score before and after intervention among intervention and control students

Group	Module	Post-Pre	Paired Differences					t	df	Sig. (2-tailed)
			Mean	Std. Deviation	Std. Error Mean	95% CI of the Difference				
						Lower	Upper			
Intervention	Pair 1 (Knowledge)	post-IP - pre-IP	39,5292	13,3782	1,2213	37,1109	41,9474	32,368	119	,000
	Pair 2 (Fitness)	post-IF - pre-IF	8,317	2,622	,239	7,843	8,791	34,749	119	,000
Control	Pair 3 (Knowledge)	post-KP - pre-KP	13,0833	8,3447	,7618	11,5750	14,5917	17,175	119	,000
	Pair 4 (Fitness)	post-KF - pre-KF	2,217	2,026	,185	1,850	2,583	11,986	119	,000

KP : knowledge score among control group; IP : Knowledge score among trial group
KF : fitness score among control group; IF : Fitness score among trial group.

Table 5. Summary of mean difference between trial and control student group on the increased score of knowledge and physical fitness

Group	Module	Post & Post	N	Mean	Std. Deviation	Std. Error Mean
Knowledge	Pair 1 (Intervention vs Control)	post-KP	120	53,962	9,3413	,8527
		post-IP	120	78,188	9,8206	,8965
Fitness	Pair 2 (Intervention vs Control)	post-KF	120	11,17	1,687	,154
		post-IF	120	17,18	1,986	,181

KP : knowledge score among control group; IP : Knowledge score among trial group
KF : fitness score among control group; IF : Fitness score among trial group

Table 6. Results of paired t-test of Posttest of knowledge score and physical fitness score among Intervention group versus control group

Module	Module	Post & Post	Paired Differences of Mean	Std. Deviation	Std. Error Mean	95% CI of the Difference		t	df	Sig. 2-tailed
						Lower	Upper			
Knowledge	Pair 1 (Intervention vs Control)	post-IP VS post-KP	24,22	12,47	1,138	21,97	26,48	21,27	119	,000
Fitness	Pair 2 (Intervention vs Control)	post-IF VS post-KF	6,00	2,68	,245	5,52	6,49	24,52	119	,000

KP : knowledge score among control group; IP : Knowledge score among trial group
KF : fitness score among control group; IF : Fitness score among trial group

It is evident that the intervention group on anticipation of tsunami disaster compared well with the control who did not received the intervention module. The null hypothesis that there was no significant differences between intervention and control group at the end of the trial was rejected. Therefore, it was concluded that there was a significant bigger increase on both knowledge and physical fitness score after the trial period among the intervention group than the control group. It proves that the module of anticipation of tsunami disaster among school children was effective.

4. DISCUSSION

Based on the evidence obtained from this study, we were convinced that the developed game model was effective in significantly increases both the knowledge of tsunami disaster anticipation and physical fitness among elementary school children aged 10 to 12 years in Banten and West Sumatra Provinces. The magnitude of the improvement was significantly larger among the intervention group than the control. In other words, the game model developed has been proved effective in improving students' cognitive understanding of the anticipation of the tsunami disaster.

The results of this study was supported by other studies written by Bluma and Malgorzata (2018) which concluded that the impact of sports on pre-adolescents' cognitive functions was enhanced by sport activities. They also stated that sports conducted regularly on pre-adolescent children can have an impact on the development of cognitive functions of children. This can be explained by the fact that during playing, the children feel happy and enjoy beyond their conscious threshold. When the children are happy, the brain will issue reciprocity in the form of positive energy that is able to record information more quickly from outside to be recorded, processed and stored in the brain's memory in the long run (Al-Thaqib et al. 2018). Results of this study of model development infers that information obtained by individuals who carry out game-based activities

will affect the long-term memory and other cognitive achievements much better than the individuals who obtained the information in a conventional manner.

Referring to an observed significant increase in physical fitness among elementary school students, the findings was also supported by another study conducted by Gabbett and Jenkis (2009) who stated that athletes who practice accurate game concepts can also improve physical fitness. The explanation was quoted as "collectively, the findings demonstrate the value of game-based training for sports team athletic skills and physical fitness"

Other similar research also revealed that there are several types of physical activity that can reduce adipose fat levels when the children do certain type of activity involving playing and game concept (Grace and David 2013), such as endurance and aerobic activities, sports-based games, sports training, and active play. Their findings explained that game activities in sports were able to improve skills, cognitive abilities, and the fitness of individuals who do it proportionally.

5. CONCLUSIONS

In summary, it is concluded: 1) that the game model is able to increase the knowledge of Tsunami disaster anticipation and improve the level of physical fitness of elementary school children aged 10 to 12 years old in a learning process; 2) that the impact of the game model was bigger among intervention group than the control in terms of knowledge score and physical fitness; 3) that the tsunami disaster anticipation game model developed in the form of 30 types of games in physical education learning in the form of books with an explanation of the tsunami disaster anticipation consisting goals, rules and how to play game systematically, can be applied and be effective; 4). The results suggest that the model can be applied and be disseminated in other tsunami vulnerable areas in other provinces along the three tectonic plates surrounding Indonesia.

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DISCLAIMER: *All the views expressed in this article are our own and not an official position of the Jakarta State University.*

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