Assessing Effectiveness of the Dengue Hero Board Game in Improving Children's Knowledge and Attitudes on Dengue Prevention: A Randomized Controlled Experiment

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ABSTRACT

Educational board games have been used as an alternative method for health promotion and education. This study aimed to assess the effectiveness of the Dengue Hero board game in improving children's knowledge and attitudes regarding Dengue prevention compared to the conventional, lecture-based health promotion. In addition, students' experiences of the interventions were also assessed. This was a randomized, controlled experimental study involving 64 8th grade students from a secondary public school. Three regular classes were randomly selected, and students were randomly assigned into two groups: the board game and lecture groups. Both groups received 60 minutes of the respective intervention. Pretest and posttest were conducted using a validated knowledge and attitudes questionnaire consisting of 26 items. Participants' experiences for each intervention were assessed using two 10-item questionnaires. Before the interventions, there were no significant differences in participants' knowledge and attitudes in both groups. After the interventions, the knowledge and attitudes in both groups improved significantly. The improvement of knowledge in the control group was greater than the board game group, but there was no difference in improving attitudes between the two groups. The board game group gave a better evaluation of the experiences, although these were not statistically significant. It can be concluded that the "Dengue Hero" board game effectively improved students' short-term knowledge and attitudes on Dengue, but the conventional approach was more effective in improving knowledge. A combination of both methods could make learning effective and enjoyable.

Keywords: Dengue, board game, knowledge, attitudes, health promotion, health education

1. INTRODUCTION

Dengue, an infection caused by the Dengue virus (DENV) and transmitted by female *Aedes* mosquitos, is considered a disease of global burden [1]. It is estimated that 390 million Dengue infections happen annually, with clinical manifestation in 96 million among them [2]. Total Dengue cases increased four-fold from 23 million in 1990 to almost 105 million in 2017. So did the incidence rate, which rose from 431.6 (8.4 – 961.0) per 100.000 population in 1990 to 1371.3 (834.5 – 2079.3) in 2017. It is estimated that 100 million Dengue infections and 40 000 deaths had occurred in 2017. South-East Asia, South Asia, and the Caribbean are most burdened with Dengue [3].

Indonesia is a country with the third-highest Dengue incidents rate and had the highest age-standardized DALY rates in 2017. Although it also showed decreasing Dengue mortality between 1990 to 2017 [3]. According to a study conducted in seven cities in Indonesia, Dengue virus infection is a common cause of hospitalization due to acute fever [4].

According to studies in Latin America, children and adolescents are population groups with the highest risk of Dengue infection [5,6]. In Indonesia, a study in West Java showed that children aged 5-15 accounted for 30% of Dengue cases [7]. Utama et al. [4] found that almost half of Indonesian children under five years of age had been exposed to the virus. DENV seroprevalence increases with age, with 90% of individuals between the

ages of 12 and 25 and almost 100% in adults over 25 years old having been exposed to Dengue infection. Previously, a national-level study in Indonesia identified 50% of children had had a primary Dengue infection by the age of five, and 80% of children had had it by the age of ten. [8].

Lack of effective mosquito control, lifestyle changes, unplanned urbanization, and globalization are the four main drivers of the dramatic increase of incidence and geographic expansion of Dengue infection [9]. Lifestyle changes have contributed to the abundance of Dengue vector breeding sites, while vector control measures require continuous community participation [9].

With the economic development, the size of urban areas in countries has been expanding. The size and density of the urban population provide a large source of blood meal for the mosquitos. Evidence showed that the densities of adult mosquitos, the larval stages, larval development rates, and survival times of the adult mosquitos are higher in urban areas than the suburban and rural areas [10]. Therefore, increasing the vector capacity and potential of Dengue transmission. In addition, globalization drives the expansion of Dengue infection, as global travels move people from and to endemic areas, hence the infected humans as sources of infection [9].

There is no definitive antiviral therapy for Dengue. Therefore, dengue patients mainly rely on symptomatic and supportive treatment. In addition, the limited availability and use of the Dengue vaccine Dengvaxia, which is currently licensed in 20 countries and only recommended to be used in Dengue seropositive people, limit the use of this vaccine to prevent the disease World Health Organization (WHO), 2021). Therefore, vector control is still the mainstay approach to prevent transmission of the disease and reduce the morbidity of Dengue [1,3].

As mentioned above, vector control measures require community participation, particularly in preventing mosquito breeding and larvae monitoring [1]. In Indonesia, community engagement in Dengue prevention is sought through mosquito nests eradication campaign (Pemberantasan Sarang Nyamuk – PSN) [11]. The campaign encourages community involvement in the environmental, biological, and chemical control of the Dengue vector. The tagline of this campaign, 3M Plus, mainly encourage activities aimed at environmental control such as draining, cleaning, and covering water storages, and burying scraps which can potentially collect water, as well as biological and chemical control

as additional activities, hence the name 3M Plus [11]. In addition, community members are encouraged to participate in larvae monitoring as Jumantik (Juru Pemantau Jentik – Larvae monitoring cadre) with the "one-house one-jumantik" movement and school children jumantik. Thus, school children, which comprised 20% of Indonesia's population and distributed in all areas in Indonesia, were recognized to play essential roles in Dengue prevention [12].

There is a correlation between knowledge, attitude, and practices of Dengue prevention. A study in the Aceh region of Indonesia showed a significant positive correlation between knowledge and attitude, knowledge and practice, and attitude and practice [13]. Studies in other endemic countries like Sri Lanka [14] and Malaysia [15] found that school-based health education among school children improved awareness of Dengue also successfully improved practice. In their study, Radhika et al. [14] found a reduction in vector breeding within the school environment at one month and two-month post-intervention. These findings support the role of school children in vector control and highlight the need to improve children's knowledge and attitude regarding Dengue infection prevention to engage them in practice.

A systematic review study found that playful and spontaneous strategies and strategies that actively engage students in practical activities were the most attractive and effective in educating children and adolescents about Dengue [16]. Furthermore, as the authors of the study call it, ludic strategies exhibited higher engagement and increased knowledge, attitudes, and practice. The game-based approach can tackle real-world challenges and is increasingly used in health education [17,18]. However, despite the popularity of digital games, non-digital games like board games have been studied in health research [19,20].

A board game is played by "placing, moving, or removing pieces on a board" in a particular pattern [19]. They have been used to improve knowledge, attitudes, behaviors, biological indicators, social and cognitive functioning, and psychological symptoms like anxiety [19,20]. Board games can encourage learning in a fun and enjoyable way. It also enhances interpersonal interactions among players and improves motivations [19]. The use of board game in educating children about Dengue were documented in the literature [21–23]. In those studies, board game intervention improved children's knowledge [21,23] and positive attitude toward Dengue [22,23].

"Dengue Hero" is a board game developed by students and academicians in Mataram, Indonesia [24]. Based on the result of the previous playtest, the difficulty level of this game is suitable for older children, i.e., secondary school students. We aimed to assess the effectiveness of the Dengue Hero board game to improve students' knowledge and attitudes regarding Dengue prevention. In this study, we compared the board game to the conventional, lecture-based method. The experience of playing the Dengue Hero board game was evaluated and compared to the lecture. There are three questions to be answered in this study: (1) Can playing the Dengue Hero board game improve secondary school student's knowledge and attitude toward Dengue prevention? (2) Is playing the Dengue Hero board game more effective than attending conventional, lecture-based health education in improving secondary school student's knowledge and attitude towards Dengue prevention? (3) How do the experiences of playing the board game differ from attending conventional, lecture-based health education?

2. METHODS

This randomized controlled experimental study was carried out in October 2019 over one week. The Research Ethics Committee of The Faculty of Medicine, Mataram University, had approved this study, with decision No. 165/UN18.F7/ETIK/2019.

2.1 Study Participants

The population in this study was junior high school students in Indonesia, and the accessible population was 8th-grade students in a public Junior High School in Kota Mataram (Sekolah Menengah Pertama Negeri 15 Mataram) in the academic year of 2019. The inclusion criteria for the study were students of regular 8th-grade classes who agreed to participate, while the exclusion criteria were those who were absent at the time of intervention or did not complete the pre-/posttest and the experience questionnaire. The sample size for this study was calculated based on the sample size formula to compare two means, as shown below. We calculated the combined standard deviation from the standard deviations of knowledge score in a study that compared the secondary school students' knowledge of First Aid for who played the "First Aid" game versus attending the lecture[25].

SG (calculated from the previous study) = 1,23; Zα = 1,96; Zβ = 1,282; X1-X2 = 1

$$n_1 = n_2 = 2 \left[\frac{(1,96 + 1,282)\ 1,23}{(1)} \right]^2$$

$$n_1 = n_2 = 2 \frac{[3,96]^2}{1}$$

$$n_1 = n_2 = 2 \times 15,68$$

$$n_1 = n_2 = 32$$

There were ten classes of 8th grade, and all were regular classes. First, three classes were randomly selected. Next, a simple random selection was performed using a lottery to select 68 students from the three classes' students. Selected participants were then assigned to one out of two interventions. All the processes, from random selection to intervention assignment, were performed by the first author (MBF).

2.2 The Interventions

All participants received one of the two health education interventions regarding Dengue and its prevention: playing the Dengue Hero board game or attending an interactive lecture and discussion. Participants assigned into the board game group were given a briefing about the rules and mechanics of the game for 10 minutes before playing the game for 60 minutes. As a maximum of four players can play one board game, there were eight board game playgroups in the intervention group. As this board game was new for the students, the research team assisted each group with a game assistant. The game assistant briefed students and served as a guide during the gameplay, also providing some small discussion after a card was solved to aid in obtaining the knowledge by the student. The author (MBF) was also involved as the guide for the game. In addition, the teachers were present to observe students during the gameplay.

Meanwhile, the interactive lecture group participants received 40 minutes lecture about Dengue infection and prevention, followed by 20 minutes question and answer session. A General Practitioner and academician, and a member of the research team (DPS), delivered the lecture using a projected, Microsoft PowerPoint slide presentation. The presentation covered similar information as found in the board game. The lecture's content includes the Dengue virus, the vector characteristics, life cycle, the potential place for Aedes breeding, signs and symptoms of infection, preventive

methods, early management of DHF, and what we should keep in mind about DHF. Both interventions were delivered face to face in a separate classroom setting at the same time.

2.3 Data collection instruments

2.3.1 Pre- and posttest questionnaire

The participants' knowledge and attitudes about Dengue and its prevention before and after intervention were assessed using The Dengue Knowledge and Attitude questionnaire for children previously developed by Firazullah et al.,[26]. The questionnaire consisted of 12 multiple-choice items to evaluate knowledge and 14 statement items for assessing attitude about Dengue and its prevention. The questionnaire's validity and reliability had been considered. The knowledge and attitude items showed evidence of validity (all items have corrected item-total correlation > 0.3), acceptable reliability for the knowledge items (Cronbach's alpha = 0.674), and good reliability for the attitude (Cronbach's Alpha = 0.848).

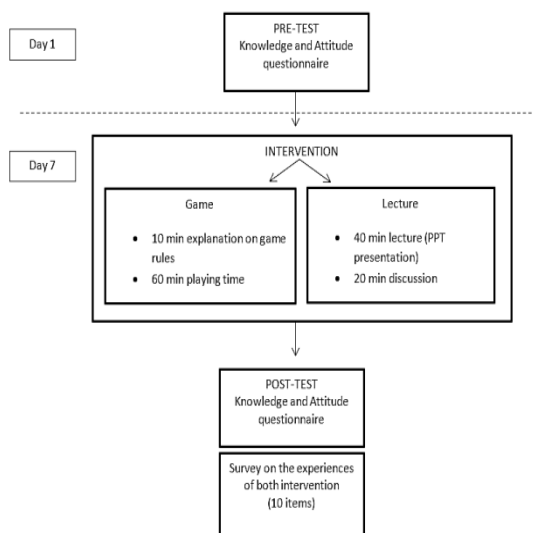### 2.3.2 Intervention experience questionnaires

Figure 1 Study procedure

Figure 2 The "Dengue Hero" board game set

Two questionnaires were developed to assess participants' experiences of the interventions. Both questionnaires consisted of 10 statements, and the participants were required to rate their agreement for each statement using a 5-point semantic differential rating scale (1 being "highly disagree" to 5 being "highly agree"). Participants filled in this questionnaire after the posttest.

2.4 Study Procedure

Students' knowledge and attitudes towards Dengue and its prevention were tested on two separate occasions: seven days before the educational interventions and immediately after the interventions. The questionnaires were administered on paper and pencil. Figure 1 shows the study procedure.

2.5 The Board Game

The "Dengue Hero" board game consists of a board, 40 cards (31 questions cards and nine action cards), four pawns, one guide flyer, 60 coins, and two dices (Figure 2). The questions cover several aspects: knowledge about the virus, the vector, transmission, symptoms, prevention, early management, and attitudes toward Dengue infection (perception of danger, risks, and attitude toward preventive actions). Two to four players can play this game. In this game, each player, in turn, picks a card from the stack, reads the question in the card aloud, and tries to answer the question. The correct answer is provided on the folded side of the card, which may not be opened before the player answer the question.

Players will get points by answering the question or guessing the action correctly. The game is over when a player reaches the "finish" line with four question cards and three action cards obtained, and the winner is the one who had the second-highest coins. The board game was evaluated in a playtest with elementary school students and was considered rather complex for elementary level students [24].

2.6 Data Analysis

All data analysis was carried out using the SPSS 20.0 software. Only students who participated in the pre, posttest, and intervention experience survey were included in the analysis.

The descriptive statistics data (pre-and post-knowledge, pre-and post- attitudes, change in knowledge, change in attitudes, participants' rating of the experiences) are presented as means and standard deviations when the data were normally distributed, otherwise median, minimum, and maximum were used.

A paired T-test was used to compare the knowledge and attitude before and after each intervention when the requirements of parametric tests were met; otherwise, a Wilcoxon sum rank test was used. To compare between group's knowledge, attitude, and experiences, either an independent T-test or Mann Whitney test was used, depending on whether the parametric test requirements were met or not.

3. RESULTS

A total of 64 students participated in this study, with 32 participants for each group. Participants' age ranged from 11-15 years for both groups (mean = 13; p = 1.00). There were 40 (62.5%) female students and 24 (37.5%) male students participating in this activity, with each group consisting of 12 male and 20 female students, respectively.

Both groups did not show differences in knowledge and attitude toward Dengue and its prevention before the intervention, as shown in Table 1.

Table 1 Pre- and Post-Test Mean Score and Standard Deviation of Participants by Group

Knowledge		Pre Mean (SD)		Post Mean (SD)	
Lecture Group (N = 32)	Mean (±SD)	34.18 (±13.62)		78.06 (±14.49)	p<0.001a
Board game Group (N = 32)	Mean (±SD)	33.09 (±12.09) p = 0.735b		55.56 (±14.67) p< 0.001b	p<0.001a
Attitude		Pre Median (min – max)		Post Median (min – max)	
Lecture Group (N = 32)	Mean (±SD)	84.00 (60 – 94)		86.50 (73 – 100)	p = 0.001d
Board game Group (N = 32)	Mean (±SD)	84.00 (70 – 96) p = 0.893c		88.00 (61 – 99) p = 0.909c	p = 0.012d

a = Paired T-test, b = Non-paired T-test, c = Mann Whitney Test, d = Wilcoxon sum rank test

After the intervention, both groups showed significant improvement in knowledge (p < 0.001 for both groups) and attitudes (p = 0.012 for board game group and p = 0.001 for interactive lecture group). The interactive lecture group showed significantly greater improvement in knowledge compared to the board game group. However, in terms of attitude after the intervention, there is no difference between both groups.

Participants' evaluation of the intervention (Table 2) showed no significant difference between the two groups

except in statement 8. Participants in the board game group rated higher interest in replaying the game than learning more about Dengue among the lecture group participants. Although not significant, the board game participants' rate the experience less tedious and "just a waste of time", compared to the lecture group as seen in statement 3 (I felt bored in this activity) and statement 5 (I felt that attending this activity was just a waste of time). In addition, participants in the board game group also considered the activity more interesting and fun.

Table 2 Participants' experiences of the intervention

Group	Statement	Mean	P**
BG	1. When I saw the board game, I was interested in playing it	4.19	P=0.628
Lecture	1. I feel interested in participating in this DHF lecture.	4.13	
BG	2. It was fun to play this board game	4.25	P=0.628
Lecture	2. The presentation about DHF was interesting to me	4.19	
BG	3. I felt bored in this activity*	2.53	P=0.844
Lecture	3. I felt bored in this activity*	3.75	
BG	4. The game was too easy for me*	2.81	P=0.826
Lecture	4. I have often heard about Dengue prevention*	3.06	
BG	5. I felt that attending this activity was just a waste of time*	1.97	P=0.431
Lecture	5. I felt that attending this activity was just a waste of time*	3.97	
BG	6. To me, the story in the board game was interesting	4.38	P=0.276
Lecture	6. To me, the presentation was interesting	4.16	
BG	7. I understand more about DHF after participating in this activity	4.41	P=0.902
Lecture	7. I understand more about DHF after participating in this activity	4.50	
BG	8. I want to replay this game to win	4.31	P=0.015
Lecture	8. I want to know more about Dengue after attending this activity	3.81	
BG	9. I hope there will be more fun educational activities like this in the future	4.41	P=0.106
Lecture	9. I hope there will be more fun educational activities like this in the future	4.22	
BG	10. I want to tell others about this activity and DHF after school	4.28	P=0.982
Lecture	10. I want to tell others about this activity and DHF after school	4.28	

*Negative statements – lower mean represents a better evaluation of the experience **Mann Whitney test

4. DISCUSSION

This study aimed to assess the effectiveness of the "Dengue Hero" board game in improving the student's knowledge and attitude toward Dengue prevention compared to the conventional, lecture-based method. Our findings showed that the "Dengue Hero" gameplay approach resulted in a significant knowledge gain and improvement in the attitude of the 8th-grade students. However, the knowledge gained in the lecture group outperformed the board game group. Nevertheless, none of the interventions was more effective than the other in improving students' attitudes toward Dengue. Lennon and Coombs [21] tested the "Goodbye-to-Dengue game" in primary and secondary school students in the Philippines and compared it with the lecture method. They also found that the lecture method was more effective despite the significant increase of knowledge in both groups. Like the Dengue Hero board game, Goodbye-to-Dengue also employs question and answer as the learning mechanics. According to Gauthier et al. [20], most board games in health and medicine reviewed in their study also use this learning mechanic. Players make progress by answering the question cards correctly. Hence the more cards are opened, the more information one can learn. Thus, gaining knowledge through playing board games differs from attending the lecture where the information is readily presented to the students, not to mention the teacher's performance in presenting the

information. A lecture delivered by the best performance teacher, according to Lennon and Coombs [21], can be viewed as a maximum effort in that form of learning. However, for a board game to be played in a single session, at the same duration as a lecture, it might be considered a minimum.

The conditions for the game over in the Dengue Hero can be met before all the cards are opened. Players might not discover all the information in a single round game. Hence, one needs to play multiple times to get all the cards opened. Therefore, the longer time allocated to play and the more opportunities to replaying the game could improve knowledge gain.

Other studies that employed and assessed the effectiveness of board games in educating school children about Dengue in Brazil (Beinner et al., 2015) and Venezuela [27] also demonstrated a significant increase of knowledge after playing their Dengue games. The Brazilian study compared the board game intervention with a standard informational package from the government instead of a lecture [22]. Meanwhile, the Venezuelan study employed repeated game sessions over 60 days and other learning instructions involving the teachers [27]. The effect of playing board games on attitudes toward Dengue prevention was also studied by Lennon and Coombs [21], Beinner et al., [22] and Amelia et al. [23]. The latter study by Amelia et al. was conducted in an Indonesian setting in elder elementary

students (4th to 6th grade). Beinner et al. [22] and Amelia et al. [23] found significant impacts of playing the board game on students' attitudes. The improvements were better than the other group who received educational brochures or leaflets published by the Brazilian and Indonesian governments. However, in the Filipino study [21], the board game group did not significantly improve attitude compared to the small but significant improvement in the lecture group. To exert a higher impact on attitude, they suggested using theories to guide the game development, for example, by explicitly including the concept of severity and susceptibility in the game using a health belief model [21].

The impact of board games intervention used in health and medicine have been reviewed systematically by Gauthier [20]. Through a meta-analysis, Gauthier found that board games have a large effect on health-related knowledge, a small effect on health-related beliefs and attitudes, and a small-to-moderate effect on behaviors compared to other control conditions. In addition, board games also showed an effect on biological health indicators in a small-to-moderate size. This study highlighted the value of board games in improving negative behaviors stemming from the lack of knowledge. In the case of Dengue, we could expect that the knowledge gained from playing the board game will raise awareness and a sense of responsibility and enhance students' engagement in preventive actions (i.e., larvae monitoring). Indeed, after playing the board game, a study showed a significant increase in student proportion who consider that all family members are responsible for keeping their home from mosquitoes [22].

Regarding the experiences, the board game group in our study gave a higher rating to the fun aspect of the activity and a lower rating, therefore disagreement, to the feeling of boredom. In addition, playing the board game was not considered a time-waster. However, there were no significant differences found with the other group. Nevertheless, participants in the board game group showed eagerness to replay the game to win. The rating in this statement was significantly higher than the motivation of the lecture group to learn more about Dengue after attending the activity. As in other studies cited by Noda, Shirokutsi and Nakao [19], board games are considered a playful and enjoyable learning method. Players also acquire knowledge from the interactions and exchanges of experiences with other players. They concluded that in addition to enhancing learning, board games could also increase motivation and social interactions. Consequently, the game approach can

reinforce concepts learned from a lecture in a more student-centered way [21,25].

4.1 Limitation

This study only assesses knowledge and attitudes before and immediately after a single session intervention. The longer-term knowledge retention effect [25] is unknown. So does the effect of multiple-play sessions or a combined method [27]. Charlier and de Fraine [25] found that although the knowledge gained from the board game outperformed those gained from the lecture, the loss after two months in the board game was lesser than the lecture group. In addition, this study did not assess if the increased knowledge and attitudes led to any behavioral changes or environmental outcomes (i.e., larvae free index, house index, container index).

Future studies can assess knowledge retention of board game intervention and compare it with the conventional lecture-based method. A combination of both methods can be promising and need to be empirically proved.

5. CONCLUSION

Playing the "Dengue Hero" board game significantly increased 8th-grade students' short-term knowledge and attitude on Dengue and its prevention. Although the lecture-based method was more effective in improving knowledge, none of the methods was superior to others in improving attitudes. In addition, the board game method was more enjoyable. Hence, a combination of board games and conventional methods could make learning more effective and enjoyable.

AUTHOR'S CONTRIBUTION

Mochamad Bagus Ferdiawan – Developed the study proposal, conducted data collection and data analysis, prepared draft of the manuscript

Dian Puspita Sari – Gave inputs to the study proposal, conducted the lecture intervention, reviewed the data analysis, and finalize the manuscript

Sigit Kusdaryono – Gave inputs to the study proposal and reviewed the data analysis

Dewi Suryani– Gave inputs to the study proposal and reviewed the manuscript

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