The utility of a board game for dengue haemorrhagic fever health education

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Abstract

Purpose – The purpose of this study is to test the effectiveness of an educational board game for increasing knowledge, positive attitudes-beliefs, and self-efficacy for dengue prevention in a sample of Philippine school children and adolescents. Effective board games are more advantageous than lectures because they are adaptable, inexpensive and foster learning independently of teachers or lecturers. Also tested were relationships between perceived fun by students playing the game and outcomes.

Design/methodology/approach – A school-based pre-test/post-test experimentally controlled design was employed in a Filipino primary and secondary school population.

Findings – The lecture was more effective in increasing knowledge. But neither was more effective than the other in increasing positive attitudes-beliefs and self-efficacy. Both modes produced specifically significant increases in knowledge and self-efficacy; only the lecture produced significant increases in attitudes-beliefs. Also, there was a significant relationship between fun and self-efficacy in the game group at the reduced regression model level but not in the presence of all study variables.

Research limitations/implications – No long term outcomes or behavioral change outcomes were measured. However, an educational game may increase knowledge and self-efficacy about the dengue fever without the assistance of a teacher or other pre-game instructional aids. In addition, the board game technique is flexible and easily adapted to other community or school health issues.

Originality/value – This was the first experimentally controlled study on the use of a game with the topic of dengue. The study on the use of a game was the first to demonstrate a significant increase in self-efficacy as a result of the play of a board game. Original instruments measured self-efficacy related to dengue control and also the variable of fun.

Keywords Health education, Indoor games, Philippines

Paper type Research paper

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Introduction

Dengue fever and its more severe form of dengue haemorrhagic fever is an increasing global health problem. Dengue is now endemic in all continents except Europe. Nearly 100 million people are afflicted with dengue annually (Gubler, 1998). Gubler (1996) concluded that “dengue fever is currently the most important arbovirus disease of humans” (p. 1). Besides its increasing incidence, dengue is of concern because there are no medicines for treatment and no commercially available vaccines for prevention; it can be fatal and afflicts primarily children (Gubler, 1998).

Dengue has unique aspects as a tropical child-health problem and school-health concern. First, school-age children are at greatest risk for dengue morbidity and mortality (Gubler, 1998); most Philippine cases occur in minors (Custodio, 2000). Second, schools in Thailand were found to be breeding sites for the dengue-transmitting mosquito (Swaddiwudhipong et al., 1992), while Filipino schools have potential dengue-carrying mosquito-breeding sites inside as well as outside (Lennon, 1994, 1996a, b). Further, lack of screens on windows and doors is characteristic of some Filipino schools (Lennon, 1996b). The combination of close student contact, lack of screens, and mosquito breeding sites in and around schools very likely promote dengue transmission. Third, school-age children have played active roles in school and community dengue health education and control programs. Children can be involved as health education communicators or participants in environmental clean-up programs at school and home, as well as participants in child-to-child programs (Swaddiwudhipong et al., 1992; Lennon, 1994, 1996a, b).

Because there are neither commercial vaccines for prevention nor antiviral medications for treatment (Gubler, 1998), health education at the community level is a vital part of dengue control programs. A variety of dengue-related health education programs have been conducted around the world. The elimination or control of mosquito breeding sites has been a major theme in these international programs. Health educational strategies developed to address this central issue include the following:

- in Puerto Rico, a television drama (Gubler, 1989);
- in Mexico, a photonovel and pamphlets (Lloyd et al., 1994);
- in Honduras, a calendar and a comic book (Leontsini et al., 1993) and a special course on environmental health and dengue for primary school students and their mothers (Avila Montes et al., 2004);
- in Thailand, door-to-door talks by teams of health workers and school children and use of mass media (Swaddiwudhipong et al., 1992);
- in Brazil, a primary school program including lectures and film (Madeira et al., 2002); and
- in The Philippines, learner-centered training and school-based distribution of information sheets, which students returned with parental signatures to indicate interest in participation (Lennon, 1994, 1996a).

The effectiveness and sustainability of these health educational programs are critical concerns (Gubler, 1998). In addition, there is a constant need for innovative strategies and health education materials that are culturally and age appropriate, relatively inexpensive and easy to implement. The use of educational games may be an effective...
tool to address these concerns. Millions (1999) suggested that educational games, and
board games in particular, are appropriate for the cognitive level of elementary school
students. Educational games provide a playful and exploratory means for learning in
children (Corbeil, 1999). Moreover, educational games can be implemented both in and
out of class. They can also become a learner-initiated activity requiring little or no
assistance from teachers. Finally, they can be used to involve both teachers and
students in community-wide disease control and prevention programs (Lennon, 1994;
1996a, b). Thus, a dengue-related educational game can help fill the continual need for
effective school-based health educational strategies.

There are few published experimentally controlled studies of health education
games designed for school children. (Bartfay and Bartfay, 1994; Renaud and Suissa,
1989; Yawn et al., 2000). Only one pilot experimental study has been conducted on the
use of a dengue-related educational game for school children (Lennon, 2000).
Additional studies to validate the use of dengue-related educational games for school
children will strengthen the literature on the efficacy of educational games and test the
utility of these games for dengue health education.

It is also noteworthy that relatively few educational games have been explicitly
based on theory. Two computer game studies for predominantly teenage populations
used social cognitive theory underpinnings (Paperny and Starn, 1989; Thomas et al.,
1997). Thomas et al. (1997) and Brown et al. (1997) used the self-efficacy construct in the
framework of their health educational game studies. The present study evaluated a
social cognitive theoretical framework to demonstrate the effects of an educational
game on self-efficacy played at the elementary school and high school levels.

A review of educational game studies by Randel et al. (1992) revealed that only 32.3
percent of the game treatments were superior to “conventional classroom instruction”
in producing intended outcomes. However, of the 68 studies in the review, no study
addressed the discipline of health education (Randel et al., 1992).

With respect to health education, board game studies have shown statistically
significant increased knowledge about nutrition labeling (Grechus and Brown, 2000),
driver safety (Gray et al., 1998), chronic diseases and their risk factors (Bartfay and
Bartfay, 1994), and nursing concepts (Cessario, 1987). They have also indicated
positive attitude changes about pedestrian injury (Renaud and Suissa, 1989) as well as
positive behavioral change in pedestrian injury prevention (Renaud and Suissa, 1989),
and positive motivation change in information processing (Klein and Freitag, 1991).

Two of these board game studies (Gray et al., 1998; Bartfay and Bartfay, 1994)
employed an experimental design. In addition, two studies on children (Grechus and
Brown, 2000; Bartfay and Bartfay, 1994) were carried out in elementary schools. In the
Grechus and Brown (2000) study a board game and a computer game were compared
to determine knowledge outcomes on a nutrition topic. The study concluded that board
games were as efficacious as computer games, thus bolstering the potential value of
board games for use in developing countries as appropriate technology as well as
state-of-the-art technology.

Vivas and Guevara de Sequeda (2003) conducted a quasi-experimental board game
study on dengue prevention among students in schools in a Venezuelan state with a
high prevalence of dengue. The students, aged 8-16 years, played the game during a
60-day period. The authors compared a study group exposed to both the play of the
game and additional instructional theory about dengue prevention and mosquito
control to a study group exposed only to dengue instructional theory, as well as to a control group that received standard information on dengue as part of a regular course. Post-test knowledge and practice scores significantly increased for the two study groups of combined game play with instructional theory, and the theory group alone in comparison to the control group. Students exposed to both game-play and didactic instruction had the biggest increase in post-test scores. However, the study did not evaluate the potential for the game as a stand-alone intervention to produce outcome changes. The study did not explore a major motivation for playing a game, especially outside of school; that is, whether the game was considered fun, if so why it was fun, and also the relationship of fun to the play of the game’s outcome (Vivas and Guevara de Sequeda, 2003).

With respect to the board game reported here, a pilot study (Lennon, 2000) was conducted at the Foundation University Grade School, Dumaguete City, The Philippines, on the efficacy of an initial version of the game. The pilot study involved a randomly assigned control design of 48 fifth-grade students. Both experimental and control groups received a five-minute lecture on dengue. The experimental group was exposed to the play of the game for the remainder of the class period. Pre- and post-test, the students answered knowledge and motivation questionnaires.

Using read-back readability testing, it was concluded that the students could read and comprehend all game related materials without difficulties (Lennon, 2000). Students in the experimental group were able to cover all 25 game questions and encircle the game board by play at least one and one-half times (Lennon, 2000).

The pilot study enabled us to learn several important lessons. First we learned that a sufficient number of monitors with adequate training were needed to ensure that the dengue game intervention was carried out without deviation from the study’s protocol. Second we saw the need to assess the effects of academic performance and grade level on game-play outcomes. Third, the pilot study showed the necessity for a larger test of a revised game that included more content on the topics of dengue control and mosquito characteristics as well as a comparison with a lecture-only group.

Finally, we should note that Randel et al. (1992) listed a number of like issues that could affect a game’s educational effectiveness. They urged attention to controlling for classroom and academic-related variables such as grade point average, using reliable study evaluation instruments, having sufficient sample size, guarding against misidentification of debriefing as a study variable if included prior to post-test study evaluation, and strengthening of experimental study designs.

All of the above clearly indicate the value in testing an educational tool like the dengue game with an experimental study.

**The dengue board game study**

Our study evaluates the effectiveness of an educational game for increasing the knowledge of, interest in, and self-efficacy for dengue prevention and control in a sample of Philippine school children. This is accomplished by comparing use of an educational game with that of traditional lecture instruction. Social cognitive theory constructs guided the overall design of the intervention aspects of the game. Social cognitive theory, a value expectancy theory of multiple constructs, seeks to explain behavior through various types of expectancies and incentives. A core principle in social cognitive theory is triadic reciprocal causation. Kohler et al. (1999) state:
“because the social cognitive theory is very complex and includes the notion of a dynamic interaction among the person, the environment and behavior, it is not possible to test the theory as a whole in a single study” (p. 38). Therefore, not all social cognitive theory constructs were integrated into the study. However, the following constructs (Bandura, 1997; Kohler et al., 1999) were integrated:

- behavioral capability;
- vicarious experience;
- reinforcement; and
- self-efficacy.

The design of the game board and use of the interactive cards were intended to increase behavioral capability through expanded dengue related knowledge. Vicarious learning was designed to occur through learning from other players about dengue as the game was being played. Reinforcement was achieved through knowing about correct answers to the game’s questions and through repeated response. In addition, winning the game was a form of reinforcement. Self-efficacy, the key social cognitive theory construct, was intended to increase through learning about specific environmental behaviors related to dengue along with vicarious learning and reinforcement. Active responses to game cards were designed to increase the players’ self-efficacy.

Methods

Participants
A sample of 168 participants from grades 5 and 6 of Foundation University Grade School and year one of the Foundation High School, Dumaguete City, The Philippines, completed the study. Ninety-two (54 percent) were female and 76 were male. The age range was from 11 to 14. The SAS analyses used for our relatively small population works well with up to ten variables. Thus we had to limit the number of variables and grade levels were used as a proxy for age. The grades were sequential – the first year of high school is the equivalent of the seventh grade in the USA.

This study occurred in a dengue endemic city (City Department of Health, 2001). As indicated, high school year one constituted the seventh consecutive educational year. Enrollment in the study was constituted by completion of a signed parental consent form and the pre-test questionnaire series. A total of 191 students at the pre-test enrollment out of a student population of 287 in the three grade levels returned signed consent forms. This yielded a participation rate of 67 percent. There was also an 88 percent retention rate from enrollment to completion of this study (168/191). The 168 students who completed the study are 58.5 percent of the total student population in the three grades.

The study design was a randomly controlled experiment. There were two study groups. Participants were randomly assigned to either the group exposed to the play of the dengue game or the group exposed to the dengue lecture. Random assignment was stratified by class within each grade level. The game group had 88 participants of which 53.4 percent were female while the lecture group had 80 of which 55 percent were female. The average grade level for the game group was 6.23 and grade point
average was 82.2. Corresponding figures for the lecture group were 6.14 and 82.3. The family histories of dengue and dengue incidence in the two groups were very similar.

**Instruments**
The educational game employed was called “Goodbye-to-Dengue Game” (Lennon, 2000). The game’s components consisted of a playing board and cards. Originally, the game consisted of 25 cards and 30 board spaces (Lennon, 2000). Eight new cards were added before this study. Interactive cards promoted advancement through correct responses. The play objective was to circle the playing board the most times during the entire play period. Major content areas of the game were:

- mosquito characteristics;
- dengue control;
- dengue treatment; and
- dengue signs-symptoms (Lennon, 2000).

Study outcomes were measured by knowledge, attitudes-beliefs, and self-efficacy instruments. Also, a post-test on the variable of fun assessed perception of fun for those playing the game. A post-test debriefing was also conducted for those who played the game.

The knowledge questionnaire assessed the content coverage of dengue control measures, mosquito characteristics, dengue treatment, and dengue signs-symptoms. The attitude-beliefs questionnaire assessed dengue attitudes and beliefs based on the framework of the health belief model (Rosenstock et al., 1988) and motivation based on the ARCS model; its necessary components included attention, relevance, confidence, and satisfaction (Keller, 1987). The self-efficacy questionnaire measured a participant’s confidence in performing tasks related to dengue fever control measures (Bandura, 1997). The fun questionnaire assessed the participant’s enjoyment, satisfaction, or pleasure as a result of participation in the dengue game activity based upon components described by Bisson and Luckner (1996) as spontaneity, excitement, chance, winning, and participant control. The questionnaire also included a component of satisfaction from the ARCS model (Keller, 1987).

**Tasks and procedures**
Participants were randomly divided into two groups, 88 that played an educational game called “Goodbye-to-Dengue Game” (Lennon, 2000), and 80 in a control-comparison group that received a lecture. The game group played the game for 35 minutes in the school library. Prior to play, the students received two minutes of instruction on the game’s mechanics. They were divided into play groups of three to four participants.

The lecture lasted 35 minutes. Major topical areas were:

- mosquito characteristics;
- dengue control;
- dengue treatment; and
- dengue signs-symptoms.
Subtopics such as mosquito life cycle, environmental action plan, and dengue misconceptions were included. The major topics and subtopics of the lecture and game were evaluated externally and judged as equivalent in content. The lecture did not include props or two-way discussion. One lecturer conducted the same dengue lecture to all students in their respective classes assigned to the lecture group. This student-teacher was selected as the best student-teacher lecturer by the education college and the field researcher.

Prior to the beginning of this experiment, revised game materials and the questionnaire were evaluated for readability in a selected group of fourth graders in a local equivalent school population. Readability was evaluated by a read-back method, as readability based on syllabic count methods has not yet been evaluated for this multi-linguistic area of The Philippines. This occurred under the authority of the Dean of the College of Education of Foundation University. Based upon the readability testing, the Dean determined that the materials were appropriate for use with students of the study grades.

The student teacher monitors were given an orientation questionnaire about their administration activities, as well as intervention responsibilities. In order to limit the possibilities of contamination at least seven monitors were present during all questionnaires administrations. Also, process evaluation forms were used by the monitors to evaluate the integrity of the treatments.

The study took place between February 14, 2001 and March 1, 2001 on the campuses of Foundation University Grade School and High School. The pre-test observations, lecture and game treatments, and post-test observations occurred over a three-day period. All observations and treatments occurred in school. The lecture and game treatments occurred in different locations in the school. The same instruments of the pre-tests were used for the post-tests. After post-test applications of the knowledge, attitudes-belief and self-efficacy questionnaires, the game treatment group was administered a questionnaire about fun, and also participated in a debriefing (Lennon and Coombs, 2005) about the game.

**Analytical methods**

Reliability of the study instruments was analyzed by Cronbach’s α. *t*-Test analyses were performed to detect changes within groups by evaluating changes between pre-test (or baseline) scores, and post-test (or follow-up) scores. Also, multiple regression analysis with indicator variables was employed to evaluate variables for prediction and association with play of the dengue game. Multiple regression analysis examined the mean difference between observations (pre-test and post-test). These variables were used in multiple regression analysis:

- treatment (the play of the dengue game versus the dengue lecture);
- sex of the participant;
- family dengue history;
- dengue incidence in community of student’s home residence;
- grade level;
- grade point average;
- number of times of play encircling around the game board;
perceived fun scores; and

• the number of players around the game board during play (known as the group).

The data from the pretest and post-test instruments were entered into the Access 97 data entry system. The data entry system had range checks to ensure data quality. Data entered were then merged into SAS 8.1 for analysis.

Power analysis was based upon the standardized beta at 80 percent calculated by a computer program (Dupont and Plummer, 1990). On the bases of the power analysis, a 1.21 difference between groups in knowledge, attitudes-beliefs, and self-efficacy questionnaires, should have been detectable at 80 percent power, given the full population of three grades. The figure 1.21 indicates mean difference. It is commonly referred to as the minimum detectable difference between groups. We had confidence in this because the observable change difference in the pilot study was 1.63 (Lennon, 2000).

Ethics
Prior to the start of the study permission for the dengue game intervention was approved both by the Foundation University, Vice President for Academic Affairs and the Institutional Review Board of the University of Alabama at Birmingham. Participation was voluntary. Students’ written assent was required. In addition, no student was permitted to participate without a consent form signed by their parents. The study sought to protect the participants’ human rights.

Content validity and construct validity were favorably accessed by an expert committee that included scholars in public health, health education, and tropical medicine.

Results
Reliability analysis by Cronbach’s $\alpha$ for the pretest questionnaires of knowledge, attitudes, beliefs, self-efficacy, and fun yielded the following standardized alphas, respectively: 0.25, 0.66, 0.68, and 0.77.

The issue of randomization for pre-test variables
To confirm the effectiveness of randomization t tests were conducted on the differences between the pre-test game group and pre-test lecture group mean scores for knowledge, attitudes/beliefs, and self-efficacy. The $t$ and $p$ values indicated no significant differences confirming the effectiveness of randomization.

Knowledge results
Treatment effects for knowledge. Mean posttest knowledge scores for the game and lecture groups were 5.796 and 6.838 respectively indicating knowledge gains in both groups (Table I). However, the $t$ and $p$ values for the between group difference in post-test scores indicate the lecture mean post-test score was significantly higher suggesting that the lecture outperformed the game.

Multiple regression analysis was used to adjust baseline knowledge scores (Table II). For the reduced model – containing only pre-test knowledge scores and treatment – the resultant parameter estimate (equivalent to the difference between post-test game and lecture scores) was 1.182 ($p < 0.0001$). For the full model –
containing pre-test knowledge scores, treatment, grade level, gender, grade point average, dengue family history, and dengue incidence – the resultant parameter estimate was 1.222 ($p < 0.0001$). Despite adjustment for potential confounding variables in the full model, the parameter estimate remained stable in similar value and direction to the crude post-test mean score difference of 1.042 (Table I), verifying the better performance of the lecture group.

**Knowledge change within each group.** $t$-Test analyses evaluated changes between pre- and post-test scores within each group (Table I). The $t$ and $p$ values for differences in mean scores within the game and lecture groups demonstrate statistically significant increases in knowledge scores as a result of both game play and the lecture. Thus, overall, young people in both the game and lecture groups had significantly increased knowledge scores as a result of their respective treatments.

**Attitudes-beliefs results**

**Treatment effects for attitudes-beliefs.** Mean post-test attitudes-beliefs scores for the game and lecture groups were 4.200 and 4.184, respectively, indicating small attitude-belief changes in both groups (Table III). The $t$ and $p$ values for the between

<table>
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<tr>
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<th>Pre-test</th>
<th>Post-test</th>
<th>Difference</th>
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<td>Mean</td>
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**Table I.** Effect on knowledge

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<td>Lecture</td>
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<tr>
<td>$p$ value</td>
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**Table III.** Effect on attitudes and beliefs
group difference in post-test mean attitudes-belief scores indicate no significant difference between the two groups.

Multiple regression analysis was used to adjust baseline attitudes-beliefs scores. For the reduced model – containing only pre-test attitudes-beliefs scores and treatment – the resultant parameter estimate confirmed that there were no significant differences between game and lecture post-test scores. Because the reduced model was not statistically significant, no further testing was done.

**Attitudes-beliefs change within each group.** *t*-Test analyses evaluated changes between pre- and post-test attitudes-beliefs mean scores within each group (Table II). The *t* and *p* values for the difference in mean attitudes-beliefs pre- and post-test scores for the game group indicated no significant change in attitudes-beliefs scores from pre- to post-test as a result of game play.

However, *t* and *p* values for the difference in mean pre- and post-test attitudes-beliefs scores for the lecture group indicated a significant change within that group. Thus, only the lecture group students showed a statistically significantly change in attitudes-beliefs scores as a result of their treatment.

**Self-efficacy results**

**Treatment effects for self-efficacy.** Mean post-test self-efficacy scores for the game and lecture groups were 5.544 and 5.644, respectively, indicating small increases in self-efficacy in both groups (Table IV). The *t* and *p* values for the between group difference in post-test mean self-efficacy scores showed no significant difference between the game and lecture groups.

Multiple regression analysis was used to adjust baseline self-efficacy scores. For the reduced model – containing only pre-test self-efficacy scores and treatment – the resultant parameter estimate confirmed that there was no significant difference between post-test game and lecture self-efficacy scores. Because the reduced regression model was not statistically significant, no further testing was done.

**Self-efficacy change within each group.** *t*-Test analyses evaluated changes between pre-test and post-test scores within each group (Table IV). The *t* and *p* values for the difference in mean self-efficacy pre- and post-test scores for the game group indicated a statistically significant increase in self-efficacy scores from pre- to post-test as a result of game play (Table IV).

The *t* and *p* values for the difference in mean self-efficacy pre- and post-test scores for the lecture group also indicated a significant increase in self-efficacy scores as a result of the lecture. Therefore, both groups had significantly increased self-efficacy scores as a result of their respective treatments.

<table>
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<tr>
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<th>Pre-test Mean</th>
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<th>Post-test Mean</th>
<th>SE</th>
<th>Difference Mean</th>
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<th>p value</th>
</tr>
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<tr>
<td>p value</td>
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</table>

*Table IV.* Effect on self-efficacy
The relationship of fun to game treatment

For students randomized to game playing, multiple regression analysis indicated no association between the variable of fun experienced by student play of the game and differences in dengue knowledge scores. Scores of the fun questionnaire were used in this analysis. The fun questionnaire’s overall mean score for the game group was 4.463 out of a possible 5.0. Using the multiple regression model containing post-test knowledge scores as the dependent variable, and both pre-test knowledge scores and fun scores as the independent variables, the parameter estimate for the fun variable at 0.615 (SE = 0.387) was insignificant at $t = 1.59, p = 0.116$.

As indicated previously, there were no significant attitudes-beliefs changes as a result of game treatment (see Table III). Thus, no analysis on the relationship of fun to attitudes-beliefs was conducted.

Multiple regression analysis did not confirm the secondary hypothesis that there would be a direct relationship between the element of fun experienced by the students’ play of the game and changes in dengue self-efficacy. But the analysis does suggest a possible relationship. Employing the reduced models including the fun variable had parameter estimates with $t = 1.94, p = 0.056$. The relationship was statistically significant at the $p < 0.10$ level but not the 0.05 level. However, in the presence of a full model – including game related variables such as grade level, gender, dengue history, grade point average, dengue incidence, times around the game board, and group size of game players – the parameter estimate was $t = 0.80, p = 0.426$. Thus, the effects of the fun variable were not sustained.

Discussion

Limitations

There were limitations to this study that need to be considered before generalizing beyond the study population. The game was played only in the English language. It is not known what differences, if any might have occurred if the game was played in Visayan-Cebuano, or Filipino. The student population consisted only of private school students. A sampling of public school students would aid in making any future study representative and generalizable. In addition, although we were able to enroll 191 of 287 students in the three grade levels (66.5 percent) only 168 completed the study – 58.5 percent of the entire group. The study did not assess long-term effects nor multiple play sessions. While self-efficacy was measured, no behavioral change outcomes, such as players’ reduction of mosquito breeding sites were included. Variables such as learning styles, and personality type were not assessed. The game was not used in combination with other educational strategies, such as a pre-game lecture, debriefing or experiential learning of environmental clean-up. The study was conducted during a non-epidemic period. The study could not assess seasonal change of the rainy season. The game was only compared with the top-ranking lecturer; that is, the study did not compare the game with an average-ranked teacher as lecturer. The study did not use the terms “kill” or “death” as related to dengue severity. Finally, the Cronbach’s $\alpha$ of 0.25 for the knowledge questionnaire indicates low reliability. A consultant for the methodology we used reviewed this issue. She said that because our knowledge questionnaire was based upon cognitive information and, unlike the other questionnaires, was made up of unconnected knowledge points, greater variability
of knowledge responses and hence lower reliability were not unusual, but did not indicate lack of validity.

Results
Clearly, knowledge scores increased more in the lecture group compared to the game group by $t$-test, $p < 0.0001$. This confirms the literature that the teacher (traditional class lecturer) can have a great influence on the learning acquisition process (Kolb, 1992). The lecture method may be particularly useful in conveying concepts for the first time, whereas, the game may have its strength as an educational tool to stimulate initial interest (Keller, 1987), or as a review method to enhance previous instruction.

However, the difference between game and lecture groups does not tell the whole story. Both the lecture and the game produced statistically significant increases in overall knowledge scores from pre-test baseline to post test outcome. Unlike the lecture, which is a simple episode educational activity delivered by a teacher or outside trained person, the game has potential to be used by itself as a student-directed activity. Our lecturer was selected as the best among a student teacher population and in all likelihood would have out-performed average teachers. The lecturer in our study could be viewed as a maximum in its form as an educational method. However, the game could be viewed as a minimum, in that games are designed to be played multiple times. This study showed that the dengue game evaluated here could be used to increase knowledge without the instruction of a teacher or facilitator. The Venezuelan study demonstrated significant knowledge increase with their dengue game, but that increase was not shown to be independent of dengue content instruction and related materials (Vivas and Guevara de Sequeda, 2003). Our study is in agreement with other experimentally controlled health educational studies in that knowledge was increased solely by the play of the game (Bartfay and Bartfay, 1994; Brown et al., 1997, Gray et al., 1998; Rubin et al., 1986).

The lecture was not more effective than the game in producing more positive attitudes-beliefs scores by $t$-test $p = 0.468$, and confirmed by multiple regression in the reduced model. However, the lecture produced a statistically significant, though modest 1.3 percent ($p = 0.031$) increase in positive attitudes-beliefs scores from pre-test baseline to post-test outcome while the game did not significantly increase positive attitudes-beliefs scores. This concurs with the literature where attitudes or affective change by games has been mixed, with some producing change while others do not (Bredemeir and Greenblatt, 1981).

A greater clarity in developing theory-based games may also increase affective related outcomes (Bredemeir and Greenblatt, 1981). In the case of our study the health belief model constructs of perceived susceptibility, and perceived severity (Rosenstock et al., 1988) were not directly stated in the game. For example such concepts that dengue can “kill” were avoided. The game also lacked directed student personification of their own perceived susceptibilty. These concepts should be included and strengthened in a future game.

The Venezuelan study covered one affective section on acceptance of the game process by the participants. The students rated the game process with high acceptance, a 4.25 out 5.00 score. The Venezuelan study did not cover attitudes – beliefs about dengue control or its importance, and interest in community program participation. It is also noteworthy that the Venezuelan study involved multiple educational treatment
doses over a 60-day period (Vivas and Guevara de Sequeda, 2003). Our study had the limitation of only one treatment. Changing attitudes and beliefs about health may require multiple processes and phases and more time (Prochaska and Velicer, 1997). A future study with the “Good-bye to Dengue Game” conducted over time will very likely increase the frequency of attitudes-beliefs change.

In addition, some student attitudes-beliefs may have been challenged or changed in areas not addressed in the attitudes-beliefs questionnaire. These affective changes may render themselves to discovery in an open-ended debriefing. For example, in response to the post-game debriefing question “How did you feel after the game?”, four new response item categories and 17 sub-item categories were identified among 131 total responses to that question (Lennon and Coombs, 2005). The educational value of post-game debriefing has been affirmed (Thiagarajan, 1992). Therefore, debriefing should be included as part of the learning and evaluation components of an educational game study.

Both game and lecture groups had statistically significant (>0.0001) increased self-efficacy scores by t-test from pre-test baseline outcomes within their respective groups. This is important, because self-efficacy has been posited as a key variable in causing behavioral change. (Bandura, 1997). The “Good-bye to Dengue Game” clearly demonstrated that it could increase the students’ self-efficacy without the assistance of teachers or other educational aids.

The Venezuelan dengue game study did not measure self-efficacy change. However, it detected a statistically significant increase in dengue prevention related practice/skills among the combined game with theory instruction compared to a control group; p < 0.05. Nevertheless, the Venezuelan study could not confirm the significant increase in dengue related practices as attributable only to the play of the game (Vivas and Guevara de Sequeda, 2003). A diabetes-related educational video game demonstrated increased self-efficacy changes, but at a non-significant level of p = 0.07 (Brown et al., 1997). Therefore, our study was the only one to demonstrate significant self-efficacy changes as a result of playing a health education board game.

Neither the game nor the lecture was more effective than the other in producing increased self-efficacy scores, by t-test at p = 0.697. This was confirmed by the multiple regression reduced model. The lecture method therefore cannot be assumed optimal for increasing self-efficacy for dengue control-prevention behaviors. Moreover, it is likely that self-efficacy can be increased through more episodes of playing the dengue game. Also, our dengue game may potentially enhance self-efficacy by the inclusion of more skills-oriented components. The lecture method was likely at its maximum capability to increase self-efficacy, whereas the game, in the form presented, was at its minimum capability to increase self-efficacy.

The high mean fun score suggested that the students thought the game was fun and enjoyable. Bisson and Luckner (1996) contend that fun positively makes an impact on the environment of the participant to facilitate learning. In our study we were not able to demonstrate that fun had a significant effect on knowledge among those playing the game (p = 0.116). The effect of fun on self-efficacy did yield a modest relationship at the reduced model (p = 0.056) although the relationship was not sustained in the presence of the full model of eight variables (p = 0.426).
Overall, the young people were not bored with the game. The students’ experience of fun suggest potential opportunities for future learning experiences with the dengue game.

Variables such as learners’ personality characteristics (Gray et al., 1998) and learning styles (Boyatzis and Kolb, 1991) should be considered in a future study.

Finally, it should be noted that this study builds on other studies of health education games covering a range of health topics (e.g. Gray et al., 1998; Bartfay and Bartfay, 1994; Grechus and Brown, 2000; Vivas and Guevara de Sequeda, 2003). Since our study demonstrates that an educational game like ours can increase knowledge of dengue as well as increase self-efficacy in preventing it, we believe that health educational games, and particularly board games, could be equally or more effective with almost any other health issue. Moreover, simply constructed board games like ours are inexpensive, easily adapted or flexible, and sustainable in that they can be repeated by the same players at will. Once demonstrated and played, board games do not require the presence of a teacher for primary or middle school children as would a video-type game. Board games can be played in study halls or in after-school programs or in community centers. This is especially advantageous for developing countries where teachers are busy and in short supply and where electronic games are often not available.

Conclusions
An educational board game without the assistance of lecture content or other materials increased knowledge and self-efficacy as applied to dengue. However, the lecture increased knowledge outcomes more than the play of the educational game. Most important, an educational board game increased knowledge and self-efficacy outcomes without teachers or others present to manage game activity.

Fun did not have a relationship with game related knowledge outcomes or a sustainable relationship with self-efficacy outcomes. However, the perceived fun aspect of a game may have influenced a learner to initiate game play, and sustain play long enough for the game’s material and content to influence outcome changes.

Other conclusions include:

- The board game should be tested over an extended period of time, and with multiple educational doses and compared with different lecture styles/competencies.
- The average public school population should be included in a future trial.
- The game as an educational tool may be enhanced by the inclusion of other strategies, such as debriefing, skills activities, and more rigorous theory-based educational content.
- The dengue game may be included as a component for integrated community dengue prevention campaigns. Thus, for example, it could be used alone as well as combined with a lecture format as in Venezuela (Vivas and Guevara de Sequeda, 2003). Further, the simple board game format is useful and easily adapted not only for schools, but also for home, community, and other non-formal settings.
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