Development of a contextual decision-making game for improving students’ learning performance in a health education course

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Abstract
Health education is an important component of the curriculum for fostering children’s correct health knowledge and good daily life habits. However, educators have indicated that most children might fail to realize the importance and meaning of health education content owing to the lack of authentic scenarios and daily life experience. With the advancement of computer technologies, researchers have tried to develop multimedia learning content in order to improve students’ learning performance. Among various technology-enhanced learning alternatives, digital game-based learning has been recognized as a highly potential approach to motivating students. However, several previous studies have indicated that, without properly incorporating learning content into game scenarios, the effectiveness of digital game-based learning might not be as good as expected in comparison with conventional technology-enhanced learning. In this study, a contextual digital game was developed for improving students’ learning performance in an elementary school health education course. A quasi experiment was conducted to evaluate the effectiveness of the proposed approach by situating the experimental group in the game-based learning scenario and the control group to learn with conventional e-books. The experimental results showed that the proposed approach not only improved the students’ learning motivation, but also their learning achievement and problem-solving competences. Moreover, the significant two-way interaction suggested that the contextual game-based learning approach benefited the higher motivation students more than the lower motivation ones in terms of the advanced knowledge, showing the importance and potential of applying contextual games to health education activities.

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1. Introduction

Health education has been identified by educators as an important component of the curriculum for fostering children’s correct health knowledge and good daily life habits (Noguera, Jiménez, & Osuna-Pérez, 2013; Sisask et al., 2014; Thomas, 2013). On the other hand, educators have indicated the challenges of teaching health education courses owing to the lack of learning activities that help students experience the importance of having sufficient health knowledge in their daily life (Asuero et al., 2014; Chuang & Tsao, 2013; Consorti, Mancuso, Nocioni, & Piccolo, 2012).

Due to the development of computer and multimedia technologies, many scholars have attempted to employ digital learning content to improve students’ learning motivation. Many studies have examined the effectiveness of technology-enhanced learning and have reported its benefits (Abdulla, 2012; Chow, Herold, Choo, & Chan, 2012; Pivec, 2007). For example, Chuang and Tsao (2013) found it effective to use the mobile phone short message service to enhance nursing students’ knowledge of medication; Kazemi, Cochran, Kelly, Cornelius, and Belk (2014) employed mobile applications to reduce high risk drinking among underage students. On the other hand, researchers have also indicated that, without proper learning design, technologies might not be helpful, or could even cause negative effects in educational settings (Chu, 2014).

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Among the various technology-enhanced learning approaches, digital game-based learning has been well recognized by researchers as being a highly potential approach to motivating learners of all ages (Prensky, 2001, 2003). For example, Wolters (1999) and Prensky (2003) reported that learning via games could promote learners’ motivation and hence enhance their learning efficacy. Csikszentmihalyi (1990) further proposed the “Flow Theory” to explain the situation in which players devote themselves completely to the game scenario and ignore the changes in the environment surrounding them as well as the passage of time.

In the meantime, researchers have emphasized the importance of providing authentic contexts to help students connect the knowledge learned from the textbooks to their daily life. If learning is removed from authentic contexts, students might lack the ability of applying the knowledge to their daily life; moreover, their learning motivation might be affected (Anderson, 1993; Mayer, 2002). That is, it is important to integrate daily life contexts as well as the learning content in the gaming scenarios and engage students in making decisions to complete the gaming missions (Huang, Huang, & Tschopp, 2010; Kim, Park, & Baek, 2009; Prensky, 2001).

Therefore, in this study, a contextual digital game was developed by integrating authentic contexts of health problems and learning content of the health education course into gaming scenarios. In addition, an experiment has been conducted to evaluate the effectiveness of the proposed approach by investigating the following research questions:

1. Do the students who learn with the contextual digital game show higher learning motivation than those who learn with the conventional technology-enhanced learning approach?
2. Do the students who learn with the contextual digital game show better learning achievement than those who learn with the conventional technology-enhanced learning approach?
3. What is the relationship between the contextual digital game approach and the students’ motivation levels?

2. Literature review

2.1. Digital game-based learning

An educational computer game can provide students with a learning environment in which gaming elements such as humor, suspense and drama are included in the storyline during the learning process of taking on challenges, and hence arouse students’ learning motivation (Nelson, Erlandson, & Denham, 2011). There are usually some rules and prizes in a game to guide and encourage learners to think and analyze so as to make correct and meaningful decisions (Coller & Scott, 2009); for example, in some gaming scenarios, questions are used to provide hints or guides to learners for solving problems, initiating thinking, or completing learning tasks (Sung & Hwang, 2013).

Roussou (2004) has pointed out that computer games can increase students’ enjoyment of learning and promote their learning motivation. Moreover, in comparison with conventional technology-enhanced learning approaches, educational computer games tend to provide more imaginary and challenging scenarios, and hence learners usually have more interactions with the learning systems (Hwang, Sung, Hung, Yang, & Huang, 2013). Lancy (1987) summarized three factors for an effective educational computer game: (1) Feedback and Fulfillment: During the gaming process, learners need to follow the gaming rules to move on. When moving from lower to higher levels, they receive immediate feedback and increasing fulfillment; (2) Curiosity and Adventure: After spending more time on an educational computer game, learners gain better gaming skills via receiving the guidance of the game and making reflections based on the mistakes they made in the previous trials, which then enables them to find and deal with new missions and more difficult gaming levels; and (3) A Sense of Achievement: For those games that are designed with the features enabling players to feel intrigued, gain new knowledge, and achieve better performance, learners are able to gain a sense of achievement (Coller & Scott, 2009). Prensky (2001) further pointed out several important factors to be taken into account when developing educational computer games, including the learning objectives, topics, achievement, feedback, conflicts, challenges, interactions, reinterpretation, and storyline.

In the past decade, various educational computer games have been developed for different educational purposes. For example, Ebner and Holzinger (2007) applied the digital game-based learning approach to teaching the theories related to concrete structures in a civil engineering course. Ketelhut and Schifter (2011) also used game-based learning to help students understand how diseases spread and to investigate the causes and effects of a disease in different situations. Hwang, Sung, Hung, Huang, and Tsai (2012) developed educational computer games to investigate the effects of learning styles on students’ learning performances. Recently, Hwang, Yang and Wang (2013) developed an educational computer game for helping elementary school students identify plants on school campuses. Kebritchi and Hirumi (2008) further reviewed several studies and reported the potential of digital game-based learning for motivating students to learn.

2.2. Contextual learning

Contextual learning refers to the process whereby learners gain knowledge by taking part in a simulation environment and having interactions with people, events, or objects within that environment (Johnson, 2002). Hull (1993, P. 41) addressed the importance of contextual learning as follows: “the mind naturally seeks meaning in context—that is, in the environment where the person is located—and that it does so through searching for relationships that make sense and appear useful.”

The concept of contextual learning was formed via observing people’s cognitive activities in daily life. Previous research has found that thinking mainly happens in the contextual and practical activities related to people’s daily life experience (Mayer, 1992). That is, people gain knowledge when they are situated in the environment or scenario where relative events or activities take place (Brown, Collins, & Duguid, 1989). Learners must learn within the environment using existing cognition to construct knowledge, and hence experience meaningful learning. Collins (1991) further indicated that contextual learning can help learners apply knowledge to various scenarios; moreover, learners’ creativity could be enhanced when facing different situations in the context. On the contrary, if context is removed from the learning process, learners might not be able to depict or recall the relevant knowledge, which might lead to poor learning results.

Therefore, an effective learning approach is to link knowledge to corresponding contexts that reflect authentic scenarios (Sadler & Zeidler, 2005; Wu & Tsai, 2007). That is, in a learning environment, the context must be sufficient to reflect practical scenarios. As Lave
and Wenger (1991) have reported in their research, midwives, tailors, navy steersmen and others all need to immerse themselves in authentic contexts to learn in order to become professionals. In other words, contextual learning is a promising approach for developing learning systems and activities. Therefore, in this study, an integrated contextual learning and digital game-based learning approach is proposed for developing effective educational computers games for health education courses.

3. Contextual decision-making game for health education

In this study, a contextual health educational digital game was developed with HamaStar SimMAGIC Designer and the Adobe Flash Development Kit. Fig. 1 shows the structure of the contextual decision-making game, which consists of a contextual gaming module, a decision making module, a gaming material database, a gaming depository database, a learning material database, and a storyline tree. The contextual gaming module presents the gaming contents based on the gaming materials (photos, images, video clips and text) stored in the learning materials database. The gaming status of the player, including the on-going storyline, the completed and uncompleted gaming tasks, and the health status of the main character, is recorded in the gaming depository database. The decision-making module interacts with the players by raising problems following the storyline tree of the game and determines the development of the storyline based on the players’ responses to the problems.

Fig. 2 shows a part of the storyline tree for guiding students to make decisions during the gaming process. The tree was developed based on the information provided by two medical experts who had more than 15 years’ experience in health care, and an elementary school teacher who had taught the health education course for more than 10 years. Different combinations of the decisions made by the players lead to different gaming results. Moreover, when the health conditions (degree of life-force) of the players are very poor, the gaming system tries to guide them to go back to previous scenarios to fix the problems.

At the beginning of the game, there is a brief introduction to the background story. During the gaming process, learners need to complete different missions by making correct decisions, which are related to the knowledge in the textbook of the health education course as well as the gaming scenarios. The background story is about the main character’s life after having surgery. The player faces three gaming scenarios and makes correct decisions to recover following the storyline of the game. In every gaming scenario, there are some problem-solving missions to complete.

The first scene is set in a ward. The main character has just had surgery. The knowledge related to postoperative syndromes is introduced. The second scene is set in a pharmacy. Through the guidance of the game missions, the players learn the knowledge of surgery medication and drug usage. The third scene is about postoperative care at home. Through the storyline design, players are able to learn the notations and procedures of health care after surgery.

Each gaming scenario consists of two or three problem-solving missions. Learners need to complete every mission in order to reach the next scenario. For example, one of the missions is related to the postoperative syndromes in the ward, which includes two steps: possible complications and how to handle them. The main purpose is to let the learners understand the possible complications, and knowledge and suggestions for health care after surgery, as shown in Fig. 3. Screen shots (1) and (2) show the interaction between two characters: the nurse and the player; the nurse is telling the player the possible postoperative syndromes, surgery medication and knowledge of drug usage.
Screen shot (3) reveals one of the possible postoperative syndromes, muscle pain, and the relevant health care suggestion. Screen shot (4) shows an event after the player made the correct decision following the nurse’s instruction; that is, he recovered soon and had a happy life after several weeks.

The second mission is about drug knowledge at the pharmacy, which includes two steps: the introduction of transplant medication, and further information about drug usage. The main purpose is to let learners understand medication-related knowledge. The last mission is postoperative care at home, which includes three steps: dietary habits, exercise habits, and further information. The main purpose is to let learners understand the correct diet, exercise habits and further information after having a disease. In every mission, learners first need to read the learning contents, and then follow the guidance of the storyline step by step. They need to pass the necessary steps to move on to the next scenario by making correct decisions. As shown in Fig. 4, in every step, there are chances for learners to make decisions based on the gaming scenarios, and different decisions might lead to completely different gaming results.

In addition, for every gaming scenario, a “helper” button is provided in the upper left hand corner. It aims to help learners review the previous contents, and provides an overall idea of the completed and the current gaming missions. As learners follow the guidance of the storyline and complete the missions, the contents increase. For example, when the story comes to the wards scenario, the mission is about postoperative syndromes, so the helper contents only include the learning contents of the two steps about possible complications as well as how to handle them, and further information after surgery, as shown in Fig. 5.

4. Experiment design

To evaluate the effects of the proposed approach on students’ learning motivation, flow experience, and learning achievement, an experiment was conducted in an elementary school health education course.
4.1. Participants

The subjects of this study included four classes of fourth graders of an elementary school in northern Taiwan. Two classes were assigned to the experimental group and the other two were the control group. There were 52 students comprised of 28 boys and 24 girls in the experimental group and 52 students comprised of 29 boys and 23 girls in the control group. The students in the experimental group learned with the contextual digital game, while those in the control group learned with the conventional technology-enhanced learning approach, that is, e-books.

4.2. Experiment procedure

To evaluate the performance of the proposed approach, an experiment was conducted in the “health care after recovering from illness” unit of an elementary school health education course. The procedure of the experiment is shown in Fig. 6. Before the learning activity, the

![Screen shots of the contextual health educational digital game.](image)

**Fig. 3.** Screen shots of the contextual health educational digital game.

![Screen shot of an event for making decisions in the game.](image)

**Fig. 4.** Screen shot of an event for making decisions in the game.
teacher introduced the basic knowledge of nutrition and health care. Following that, the students took a pre-test to evaluate their prior knowledge of health care and the pre-questionnaires of problem solving and learning motivation.

During the learning activity, the experimental group students learned with the contextual educational computer game executed on a tablet computer. On the other hand, those in the control group learned with the conventional technology-enhanced learning approach; that is, they were asked to read and interact with an e-book via the tablet computer.

After the learning activity, all of the students took a post-test, which aimed to evaluate their health care knowledge, and the post-questionnaires of problem solving, flow experience and learning motivation. Finally, six learners were selected from each group for an interview.

### 4.3. Measuring tools

The pre-test and post-test were developed by one experienced teacher and two nursing practitioners who had years of experience in health education. The pre-test consisted of five yes-or-no items and five multiple-choice items for evaluating the students’ prior knowledge.
related to health care. The post-test consisted of two parts: the first part was related to the basic conceptions of health care with ten yes-or-no items; the second part aimed to evaluate the students' advanced knowledge of the occasions and reasons for choosing different health care strategies with ten multiple-choice items (e.g., “How should one deal with the pulmonary symptoms of patients who have had surgery? (A) Drinking water and resting; (B) Practicing deep breathing and coughing; (C) Using ointment and performing abdominal massage”) and five matching questions (e.g., “What are the factors causing acute organ rejection in transplants?”). The perfect score of both the pre-test and post-test was 100. The Cronbach’s alpha values of the pre-test and post-test were 0.82 and 0.86, respectively, implying that the tests were reliable.

The questionnaires were used in this study are provided in the Appendix. The problem-solving questionnaire was developed by Pan (2001) for assessing elementary school students’ problem-solving ability. It consists of thirty items with a five-point Likert scale, where “5” represented “strongly agree” and “1” represented “strongly disagree.” The questionnaire has been adopted by researchers to evaluate students’ ability to face and solve problems in daily life (Hung, Huang, & Peng, 2008). Therefore, it was adopted in this study since one of the key objectives of the health course was to foster students’ ability to make correct decisions when facing the problems that might affect their health in daily life. The Cronbach's alpha value of the questionnaire was 0.81.

The questionnaire of learning motivation was the “intrinsic motivation” dimension of the MSLQ (Motivated Strategies for Learning Questionnaire) measure developed by Pintrich and DeGroot (1990). A total of 7 items were included in the questionnaire (see the Appendix) and were translated into Chinese for investigating the learners’ learning motivation with a five-point Likert scale, where “5” represented “strongly agree” and “1” represented “strongly disagree.” Each translated item was reviewed by a researcher who had more than ten years’ experience of studying learning motivation to check its validity, and a school teacher to ensure its understandability for elementary school students. Intrinsic motivation refers to the willingness to do something for its inherent satisfaction rather than relying on external pressures or rewards (Ryan & Deci, 2000). It was measured in this study since learning motivation was identified by several researchers as being highly related to the gaming approach (Dickey, 2007). The Cronbach's alpha value of the questionnaire was 0.88.

The questionnaire of flow experience was modified from the measure developed by Pearce, Ainley, and Howard (2005). A total of 8 out of 11 items were selected by removing those reverse question items to avoid confusing the elementary school students since it might be difficult for them to understand questions stated with reverse descriptions. The items were also translated into Chinese and were checked by the experienced researcher and the school teacher before being used in the experiment. The Cronbach’s alpha value of the questionnaire was 0.82.

The interview was conducted by asking several questions, such as “What are the advantages and disadvantages of the learning approach? Please give some examples to address your point.” “In what way do you think you are benefited by the learning approach? Please give some examples to address your point.” “Can any improvement be made to the learning approach?” “Would you like to learn with this approach in the future? Why?” and “Will you recommend this approach to your peers? Why do you think the approach will benefit them?” The purpose of the interview was to collect opinions from the participants for investigating the possible factors that might affect their willingness to learn as well as their learning performance. Moreover, it was expected that some opinions could be adopted for improving the learning system or the approach in the future.

5. Results
5.1. Analysis of learning achievements

In order to understand the learners’ learning achievements in the health education course for the different types of learning approach and learning motivation levels, two-way MANCOVA was conducted to examine the learning achievements from two aspects: (1) basic conceptions, and (2) advanced knowledge. The pre-test served as the covariant to eliminate the differences in learners’ equivalent prior knowledge before the learning activity. The group means for basic conceptions and advanced knowledge are shown in Table 1.

Two assumptions for the MANCOVA were checked before the analysis proceeded. The tests for homogeneity of regression coefficients of the covariate for the different types of learning approach and levels of prior knowledge were not significant, suggesting that a common regression coefficient was appropriate for the covariance portion of the analysis. In addition, Box’s M test for homogeneity of covariance matrices was not significant (Box’s M = 13.54, F = 1.33, p = 0.22).

As shown in Table 2, the two-way MANCOVA summary of learning achievements in the health education course indicated a significant interaction on the students’ advanced knowledge achievements (F = 7.10, p = 0.01), while no significant interaction effect was found on their basic conceptions achievements (F = 0.24, p = 0.628). Moreover, the significant two-way interaction indicates that the independent measures of learning approach and learning motivation both had impacts on the dependent measure of advanced knowledge achievements. Therefore, the simple main effect analysis needs to be further conducted for each group to explore the interactive effects of the independent measures on the dependent measures in detail.

5.1.1. The simple main effects of learning motivation on students’ learning achievement

A simple main-effect analysis was conducted to investigate the effects of students’ learning motivation on their learning achievements of the students who learned with different approaches, as shown in Table 3. It was found that the students with different learning motivation levels in the contextual game-based learning showed significantly different learning achievements (F = 7.43, p = 0.012), while no significant difference was found between the lower and higher learning motivation students for basic conceptions (F = 0.08, p = 0.786). For the conventional e-learning group, there was no significant difference between the lower and higher learning motivation students for basic conceptions (F = 0.15, p = 0.698) or for advanced knowledge (F = 1.36, p = 0.254). The results show that, when learning with the contextual game, the students’ learning motivation significantly influenced their advanced knowledge achievements in the health education course. On the other hand, when learning with the conventional e-learning approach, no significant effect of the students’ learning motivation was found on their learning achievements.
5.1.2. The simple main effects of learning approach on students’ learning achievement

A simple main-effect analysis was conducted to investigate the effects of different learning approaches on the students’ learning achievements of the students with different learning motivation levels, as shown in Table 4. For the students with higher learning motivation, there was a significant difference between the advanced knowledge achievements of the contextual game-based learning group and the conventional e-learning group ($F = 9.08, p = 0.006$), while no significant difference was found between their basic conceptions ($F = 1.66, p = 0.210$). For the lower learning motivation students, there was no significant difference between their achievements of basic conceptions ($F = 0.49, p = 0.491$) or advanced knowledge ($F = 0.60, p = 0.446$). That is, the contextual game-based approaches significantly influenced the higher learning motivation students in terms of learning the advanced knowledge of the health education course.

5.1.3. The nature of learning approach and learning motivation interaction for learning achievements

The interaction between the learning approaches and the learning motivation levels of the students’ learning achievements is shown in Fig. 7. It was found that engaging students in the contextual game-based learning environment showed significantly better effects on the students’ advanced knowledge achievements regarding the health education course than learning with the conventional e-learning approach. More specifically, the contextual game-based learning approach benefited the higher motivation students (mean = 27.65, SD = 2.76) more than the lower motivation students (mean = 14.14, SD = 1.60) in terms of advanced knowledge.

5.2. Analysis of problem-solving ability

This study performed two-way ANCOVA using the problem-solving scale of the students as the covariate to exclude the impact of the problem-solving pre-questionnaire scores. According to the non-significant interaction of the independent variable and the covariate of problem-solving ability ($F = 0.92, p = 0.341$), the use of two-way ANCOVA is appropriate.

As shown in Table 5, the two-way ANCOVA result of problem-solving ability for the health education course indicated no significant interaction effect between learning approach and learning motivation ($F = 0.14, p = 0.709$). On the other hand, the main effect of learning approach showed a significant effect on problem-solving ability ($F = 6.97, p = 0.011$). According to the group means, the contextual game-based learning group (mean = 4.46, SD = 0.09) outperformed the conventional e-learning group (mean = 4.15, SD = 0.07) in problem-solving ability. Moreover, the main effect of learning motivation also showed a significant effect on problem-solving ability ($F = 5.15, p = 0.028$), with the higher learning motivation students (mean = 4.48, SD = 0.09) outperforming the lower learning motivation students (mean = 4.14, SD = 0.10). That is to say, the contextual game-based learning strategy was helpful to the students in terms of improving their problem-solving ability in comparison with the conventional e-learning approach. In addition, the higher learning motivation students could elicit better problem-solving ability than the lower learning motivation students.

<table>
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<tr>
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<th>SD</th>
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Table 1

The group means of learning achievement for basic conceptions and advanced knowledge.

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5.3. Analysis of flow experience and learning motivation after the activity

Table 6 shows the independent-samples t-test of the questionnaire results for the experimental group and the control group. The mean value and standard deviation were 4.33 and 0.64 for the experimental group, and 3.72 and 0.95 for the control group; moreover, the independent-samples t-test result ($t = 2.74, p = 0.008$) showed a significant difference between the two groups, implying that the experimental group students were immersed within the contextual game-based learning environment, which was helpful for their flow experience.

In terms of learning motivation, the learning motivation pre-questionnaire ratings of the two groups were compared using t-test, and no significant difference was found ($t = 1.70, p > 0.05$); that is, the students’ were assumed to have equivalent learning motivations before the learning activity. Consequently, the learning motivation post-questionnaire ratings of the two groups were analyzed with ANCOVA to exclude the impact of the pre-questionnaire ratings. Table 7 shows the ANCOVA results. The adjusted mean and standard deviation were 4.62 and 0.53 for the experimental group, and 4.00 and 0.75 for the control group. A significant difference was found between the two groups with $F = 16.13$ and $p < 0.001$, implying that the contextual game significantly benefited the experimental group students in terms of improving their learning motivation.

6. Discussion and conclusions

In this study, the introduction of diseases in the health course at the elementary school level is the main teaching content. The experiment was conducted by introducing mobile devices into the classroom as a learning model for comparing the effects of the contextual digital game-based learning approach and the conventional e-learning approach on students’ learning performance in an elementary school health education course. The experimental results showed that the contextual digital game benefited the highly motivated students in terms of improving their advanced knowledge in the health course. Moreover, the students who learned with the contextual digital game revealed better flow experience, learning motivation and problem-solving competences than those who learned with the conventional e-learning approach. In the interviews, the reasons for this were investigated. One student mentioned, “The main character is appealing. We can follow the situations that the main character encountered and gain knowledge.” Other students expressed, “Through the guidance of the game, we can complete the learning tasks step by step. Because the game is fun, I would concentrate more than before.” Therefore, it is believed that the digital game learning model can effectively promote students’ learning motivation and create more flow experience. Some scholars have also pointed out that digital game learning can increase learners’ motivation (Gee, 2003; Van Eck, 2006), Csikszentmihalyi (1990) indicated that games could lead learners into a flow status. According to Garris, Ahlers and Driskell (2002), games have the features to arouse students’ motivation and hence, create flow.

First, the significant main effect indicated that the contextual game-based learning strategy was helpful to the students in terms of improving their learning achievements in comparison with the conventional e-learning approach in the health education course. Second, the significant two-way interaction indicated that, for the advanced knowledge of the health education course, the contextual game-based
learning approach benefited the highly motivated students more than it did the less motivated students. More specifically, in the contextual game-based learning group, the highly motivated students significantly outperformed the low motivated students in learning the advanced knowledge. This suggests that the contextual game could benefit the students more if their motivation was enhanced prior to the gaming activity. That is, the experimental results revealed that an extrinsic effect was obtained owing to the intrinsic motivation of the students prior to the learning activity.

Furthermore, concerning their problem-solving ability, the contextual game-based learning group outperformed the conventional e-learning group. Additionally, the highly motivated students showed better problem-solving ability than the less motivated students. It is therefore concluded that the contextual game-based learning approach is capable of engaging students in effective problem-solving scenarios by helping them make meaningful connections between the learning mission contexts and learning contents.

Through comparing these two different technology-enhanced learning models (i.e., contextual digital game and conventional e-books), the helpfulness of situating students in authentic problem-solving contexts was confirmed. They showed a better understanding of how to take care of people recovering from surgery and some information they need to attend to when they themselves are ill. Therefore, this study could be a good reference for those schools which have an interest in promoting digital learning activities. Moreover, such a contextual problem-solving gaming approach can be applied to other courses or course units, such as social studies and natural science courses.

In the meantime, the experimental results have revealed the benefits of the contextual game in terms of improving students’ motivation. This further implies that the contextual game has great potential to help students improve their advanced knowledge and problem-solving ability via enhancing their extrinsic motivation, and transfer it to intrinsic motivation, as indicated by Ryan and Deci (2000, P63) who stated that, “A person might originally get exposed to an activity because of an external regulation (e.g., a reward), and (if the reward is not perceived as too controlling) such exposure might allow the person to experience the activity’s intrinsically interesting properties, resulting in an orientation shift.” That is, those initially low-motivated students could also be benefited by the contextual game in terms of learning motivation and performance after the learning activity. In the future, we plan to investigate the effects of contextual problem-solving games from different perspectives, such as learning styles, cognitive styles and the self-efficacy levels of students; moreover, long-term experiments are going to be conducted to investigate the effect of the approach on low-achievement students.

### Table 5
The two-way ANCOVA result of problem-solving ability.

<table>
<thead>
<tr>
<th>Variables</th>
<th>SS</th>
<th>Df</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning approach</td>
<td>0.91</td>
<td>1</td>
<td>0.91</td>
<td>6.97</td>
<td>0.011</td>
</tr>
<tr>
<td>Learning motivation</td>
<td>0.67</td>
<td>1</td>
<td>0.67</td>
<td>5.15</td>
<td>0.028</td>
</tr>
<tr>
<td>Learning approach × Learning motivation</td>
<td>0.02</td>
<td>1</td>
<td>0.02</td>
<td>0.14</td>
<td>0.709</td>
</tr>
<tr>
<td>Error</td>
<td>6.68</td>
<td>51</td>
<td>0.13</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 6
The t-test result of the flow experience of the two groups.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>S.D.</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow</td>
<td>Experimental group</td>
<td>25</td>
<td>4.33</td>
<td>0.64</td>
<td>2.74</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>Control group</td>
<td>31</td>
<td>3.72</td>
<td>0.95</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 7
ANCOVA result of the learning motivation of the two groups.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>S.D.</th>
<th>Adjusted mean</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning motivation</td>
<td>Experimental group</td>
<td>25</td>
<td>4.74</td>
<td>0.53</td>
<td>4.62</td>
<td>16.13***</td>
</tr>
<tr>
<td></td>
<td>Control group</td>
<td>31</td>
<td>4.00</td>
<td>0.75</td>
<td>4.09</td>
<td></td>
</tr>
</tbody>
</table>

***p < .001.
Acknowledgments

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Appendix. Questionnaires

Learning Motivation.

1. It is important for me to learn what is being taught in the health course.
2. I like what I am learning in the health course.
3. I think that what I am learning in the health course is useful for me to know.
4. I think that what we are learning in the health course is interesting.
5. Compared with other students who take the health course, I think I know a great deal about the subject.
6. I know that I will be able to learn the material for the health course.
7. Understanding this subject is important to me.

Flow experience.

1. I felt in control of what I was doing during the learning activity.
2. I was absorbed intensely by the activity.
3. I found the activity enjoyable.
4. I was completely immersed in this learning activity.
5. I found the activity interesting.
6. During the learning activity, time seemed to pass fast.
7. The activity excited my curiosity.
8. I knew the right thing to do in the learning activity.

Problem-Solving Ability.

1. I believe I am capable of solving problems when I encounter them.
2. I believe I can solve problems with my own efforts.
3. I have several experiences of facing problems and solving them.
4. I am willing to face problems and think of a way to solve them.
5. When I encounter a problem, I will not avoid it.
6. When facing problems, I always try to solve them on my own.
7. I would consider what types of problems they are before trying to solve them.
8. I always raise questions about the things surrounding me.
9. I believe people should know where the problem is before trying to solve it.
10. I can comprehend the questions raised by the teachers.
11. In addition to comprehending the meaning of a problem, it is important to understand the reasons that cause the problem.

12. During the process of solving problems, I often collect related information.
13. When I need to solve problems, I would think about the methods and process of solving the problems first.
15. When solving problems in a team, I know how to assign tasks to team members.
16. I hope that I could think of interesting and creative methods for solving problems.
17. I can think of many methods to solve a problem.
18. I am honest during the process of solving problems.
19. I believe it is important to consider and compare the consequences of different methods when solving problems.

20. I think it is necessary to follow some standard to evaluate the appropriateness of a method.
21. I would use scientific methods to solve problems, such as conducting experiments.
22. I would design some experiments to see if the candidate methods can be used to solve problems.
23. I am able to raise questions and provide suggestions to others for improving their problem-solving methods.
24. I can judge which method is more suitable among the alternatives proposed by others.
25. Once the adoption of a method is decided, I would make efforts to use it for problem solving.
26. During the problem-solving process, I would be patient until the problems are completely solved.
(27) I would try other methods when failing to solve some problems.

(28) After the problems are solved, I would compare the practical outcomes with the expected ones.

(29) Although the problems are solved, I would keep finding a better method.

(30) I would apply what I have learned to solving the problems encountered in my daily life.

References


