# Game-Based Remedial Instruction in Mastery Learning for Upper-Primary School Students

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**ABSTRACT**

The study examines the effectiveness of using computer games for after-school remedial mastery learning. We incorporated instructional materials related to "area of a circle" into the popular Monopoly game to enhance the performance of sixth-grade students learning mathematics. The program requires that students enter the answers to avoid the shortcomings of multiple-choice questions. Throughout the game, whenever students are unable to answer questions correctly they receive immediate remedial instruction specifically for that question. This study sought to compare the effectiveness of game-based and video-based remedial instruction incorporated with elements of mastery learning. The results demonstrate that (a) both instructional videos and the proposed Monopoly game enhance the learning of mathematical concepts; and (b) the Monopoly game is more effective than instructional videos at leveraging the benefits of mastery learning. The goal of the research was to integrate games and mastery learning into after-school remedial instruction and design a game to practice the steps of mastery learning.

## Introduction

The recent application of different multimedia, such as videos (Sedaghat, Mintz, & Wright, 2011) or digital games to the field of education to enhance learning is an important development (Hwang & Wu, 2012; Liu & Lin, 2009; Liu, 2011; Sancho, Moreno-Ger, Fuentes-Fernandez, & Fernandez-Manjon, 2009; Susaeta, Jimenez, Nussbaum, Gajardo, & Andreu et al., 2010). Digital games are a form of entertainment, and therefore an effective tool for motivating students to engage in learning activities (Prensky, 2003). Those studies indicated that games have great potential to motivate students to engage in the learning process than other media. Due to the characteristics, recently, more and more digital games have been applied into diverse disciplines, such as English (Liu & Chu, 2010), mathematics (Chang, Wu, Weng, & Sung, 2012), computer science (Papastergiou, 2009) and so on. Many studies have found that game-based learning is an effective way to enhance students' learning motivation and learning performance (Chuang & Chen, 2009; Virvou, Katsionis, & Manos, 2005). O'Neil, Wainess, and Baker (2005) indicated that the alignment between game design and instructional design has a great impact on the effectiveness of students' learning. Therefore, considering how to design the digital game to fit the need of learning activities is the keystone of game-based learning (Kebritchi & Hirumi, 2008).

In order to close the achievement gaps between high and low achieving students, it is important to consider how to help students with low achievement improve their learning performance. Scholars in the field of educational research have suggested that teachers should pay more and more attention to individual differences when teaching and providing remedial instruction for students with low achievement (Lo, Wang, & Yeh, 2004; Yang, 2010). In order to remedy the shortcoming of traditional teacher-centered instruction that ignores the need of students with low achievement, Bloom (1968) proposed the idea of mastery learning. Mastery learning is an instructional method which allows students to take their time to achieve the learning goals. In mastery learning, the learning content would be broken down into several small learning units, and only the students acquire the prerequisite knowledge or

skills can move to the next learning unit. Some studies have shown that mastery learning can help teachers to diagnose students' weakness, and show positive effect on students' learning attitude (Changeiywo, Wambugu, & Wachanga, 2011) and learning performance (Wambugu & Changeiywo, 2008; Yildiran & Aydin, 2005). However, most of the studies integrated mastery learning in a formal classroom context (LeJeune, 2010; Marshall, 2009), and few studies discussed the effect of mastery learning on students' learning performance in a remedial instruction context. Therefore, in this study, we try to design a monopoly game based on mastery learning for remedial instruction, and further investigate the effect of the game on students' learning performance.

For the structure of the paper, the literature review about the relationship between educational games and remedial instruction as well as the role of mastery learning in remedial instruction was examined first. Following the section of literature review, the specific research questions were proposed. Second, the section of research methods was stated to investigate the effectiveness of the instructional video and the monopoly game on enhancing master learning. Furthermore, the section of game design section was presented to show the details of the learning content of monopoly game and the characteristics of the monopoly game for this study. Fourth, the section of results was shown to answer the research questions. Finally, conclusions and discussion were offered to highlight the contributions and significance of the study.


## Literature review

### Educational games and remedial instruction

Game-based instruction is an important method of learning. It has been found that games evoke in players the experience of flow and positive emotions (Chiang, Lin, Cheng, & Liu, 2011). A number of studies have found that the application of video games can enhance learning motivation, and learning attitudes (Lin & Liu, 2009; Papastergiou, 2009). Researchers in education have consistently argued that allowing students to study by playing would be a more effective way to improve the quality of education than endeavoring to develop new teaching materials or methods. After personally engaging in various electronic games, Gee (2007) discovered that many of the most inspired electronic toys contain important learning principles. Unlike other forms of media, games are capable of simulating the world as perceived by children, which increase their willingness to be engaged. Game-based learning theory is grounded in the concept that a competitive game environment requires students to actively participate, thereby increasing their desire to learn. Teachers who use educational computer games enhance the imagination of their students. In addition to entertaining students, games can help students to develop thinking skills (Seonju, 2002).

Instructional content expressed in a game format can hold learners' attention, and help to increase their learning motivation (Lin & Liu, 2009). Educational computer games that utilize sound, light, images, and animation can be designed to target students of a particular age. This provides an immersion environment to inspire students through the engagement in a competitive scenario. Due to the characteristics, the concept of game-based learning was applied in different domains, such as mathematics (Ke, 2008), vocabulary learning (Frederick, 2010), civil engineering (Ebner & Holzinger, 2007), and problem-solving ability (Shih, Shih, Shih, Su, & Chuang, 2010). Tüzün, Yılmaz-Soylu, Karakuş, İnal, and Kızılkaya (2009) designed a 3D computer game to teach geography to students in primary school, and the results demonstrated an increased success rate over traditional teaching methods. Papastergiou (2009) demonstrated that senior high-school students using game-based learning methods retained information about computer memory more efficiently than their counterparts who did not use games. Yien, Hung, Hwang, and Lin (2011) designed an educational game for elementary school students in a nutrition course, and they found that game-based learning can enhance students' learning achievement and attitude. Additionally, Liao (2010) analyzed 38 studies to compare the effectiveness of game-based learning and traditional instruction, and found that game-based learning is more effective than traditional instruction in Taiwan.

Although more and more researchers and teachers applied educational games into instruction to assist their students' learning (Charlton, Williams, & McLaughlin, 2005; Holmes, 2011), however, a consensus has yet to be reached regarding the influence of computer games on the cognitive processes involved in learning. To investigate the influence of video games on learning, Chuang and Chen (2009) designed a quasi-experimental study to evaluate the differences between educational games and traditional computer assisted instruction. They found that students receiving game-based instruction showed significant improvement in their ability to recall facts and in their problem-solving skills. Nevertheless, other researchers found no significant improvement in learning, despite the fact that educational games

enhance learning motivation and learning attitude (Ke, 2008; Lin & Liu, 2009). When designing educational games, designers must consider both entertainment and education (Lin & Liu, 2009). Unlike regular computer games, educational games must be based on appropriate instructional theory and integrate suitable teaching strategies to ensure the effectiveness of the games in the promotion of learning.

*Mastery learning in remedial instruction*

According to mastery learning theory (Bloom, 1981; Carroll, 1963), different students require different durations of study to attain the same degree of mastery. Bloom suggested that despite the use of nontraditional instructional methods, most educators in school settings continue to set fixed amounts of time to complete the educational content and then assess the students according to the degrees of mastery they attain. When applying the concepts of mastery learning to the design of courses, teachers should divide the curriculum into smaller units and set goals for each unit in advance (Anderson, 2000). Students learn the units in a logical sequence and are expected to demonstrate an appropriate degree of mastery (for example, 80%) in each unit before progressing to the next. Students who did not reach the requisite degree of mastery would receive remedial instruction (Davis & Sorrel, 1995). Bloom claimed that mastery learning increases proficiency and encourages positive attitudes and interest in studying (Guskey, 2007). Bloom emphasized that mastery learning is applicable to most school subjects, particularly those with a sequential nature such as science and mathematics (Guskey & Gates, 1986). Master learning has been applied to a wide range of disciplines in primary education, such as physics (Francis, Figl, & Savage, 2009; Wambugu & Changeiywo, 2008), computer science (LeJeune, 2010), and mathematics (Bowen, 2008). Yildiram and Aydin (2005) found that mastery learning significantly enhanced junior high school students' learning in mathematics, beyond what is possible using traditional instruction. Ritchie and Thorkildsen (1994) found that mastery learning helped fifth grade students perform better in mathematics learning.

There are two fundamental issues associated with mastery learning: setting aside time after class to perform remedial instruction and allowing students to study at their own pace. To address the former issue, it is our hope that engaging students in computer games will encourage them to set aside time for remedial instruction. To deal with the latter issue, we created a video game based on the board game, Monopoly, in which the learning content was divided into small units following a logical sequence based on the findings of Lalley and Gentile (2009). Students who are unable to meet a set academic standard (at a given checkpoint) receive remedial instruction for the corresponding unit by watching a remedial instructional video repeatedly until they become proficient in that unit. This arrangement ensures that students are able to progress at their own pace in the proper sequence.

The purpose of the study was to design an educational game based on mastery learning theory for after-school remedial instruction, and examine the effect of game-based remedial instruction on students learning mathematics. Three research questions are listed below:

1. Can the use of an instructional video enhance mastery learning?
2. Can the use of the Monopoly game enhance mastery learning?
3. To what extent do differences in mastery learning appear after employing the Monopoly game and after showing the instructional video?

## Methods

According to the previous literature, computer games can increase academic performance if they are used appropriately. In this study, an educational game was used for the experimental group while educational videos were used for the control group. The purpose of the study was to investigate whether both approaches to instruction are able to enhance the effectiveness of mastery learning. In addition, we examined the effectiveness of web-based remedial instruction in enhancing the learning of mathematics by providing a customized Monopoly game and self-produced educational videos.

## Participants

Nonrandom cluster sampling was employed to select students from 6 sixth-grade classes. All subjects expressed a desire to participate in remedial instruction. Following completion of a pretest assessment, the participating students

were divided into an experimental group and a control group based on the average scores for male and female students. Each group consisted of 20 males and 13 females for a total of 66 participants; however, during the experiment, four students (two were male and two were female) dropped out. The data for the four students were subsequently excluded, such that only 62 students were analyzed in the study. In the end, the experimental group included 18 males and 12 females (a total of 30 students) and the control group included 20 males and 12 females (a total of 32 students).

**Research design**

This study focused on the results of remedial instruction administered to students with a prerequisite knowledge of a particular unit of study who however failed to meet the standard scores required for the unit. Therefore, we first administered an assessment test, and students who failed to demonstrate the requisite knowledge were excluded from participation in the study. Participants were then divided into a control group and an experimental group. The students in both groups received the same instruction with the same learning content. Following the lecture, the students were assigned a written assessment, the results of which determined whether they should undergo remedial instruction.

Students in the control group, who failed to reach the desired standard (less than 80 points) according to a formative measure, used headphones and a computer in an e-classroom to watch an online instructional video. When students encountered a problem they could not solve, they could choose to watch a video pertaining to that question category. The students were allowed to watch the video and review the supplementary materials as many times as they wished. At the same time, students who reached the standard (more than 80 points) received extended instruction.

Students in the experimental group who failed to reach the standard according to the same formative measure used headphones and a computer in an e-classroom to play the Monopoly game. When they completed the game, they received extended instruction along with other classmates who reached the standard. The remedial instruction lasted 40 minutes, during which time the students in the experimental group and those in the control group engaged in the Monopoly game or online instructional video, respectively. Following the remedial instruction, a post-test exam, similar to the pre-test exam was conducted to evaluate the learning achievement of the students. The study process is presented in Fig. 1. Finally, a t-test was conducted to determine whether the results from the control and experimental groups showed significant differences. Because the study focused on students requiring remedial instruction, we excluded the data of the students who reached the standard (i.e., more than 80 in the pretest), and analyzed only the data of students who scored less than 80 on the pre-test.
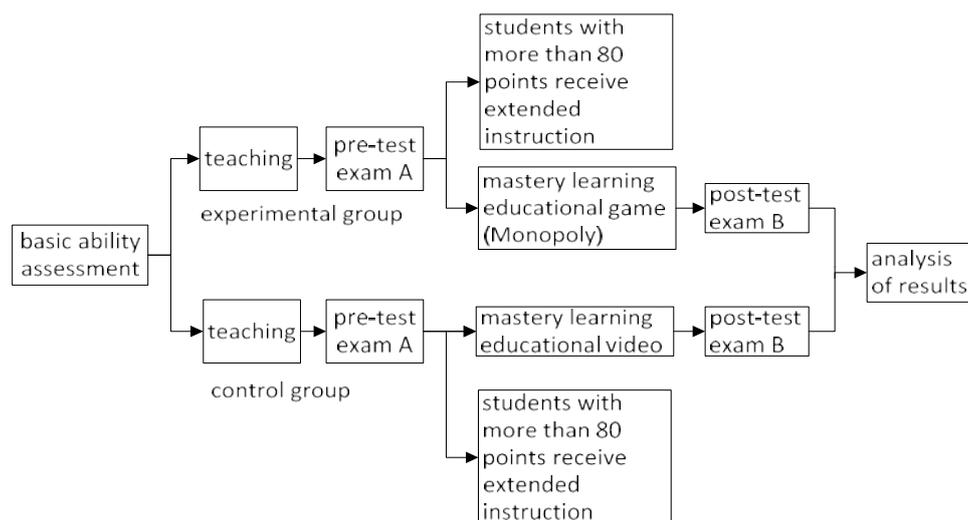


*Figure 1*. Flow chart of the experimental design

**Game design**

The goal in designing the proposed game was to optimize the benefits of mastery learning by incorporating this teaching approach within a program provided for after-school remedial instruction. In so doing, we ensured that the study objectives were aligned with the learning objectives of mastery learning. Would it be possible to design a game capable of forcing students to watch an instructional video repeatedly until they achieved mastery in that area? Could such a game motivate participants to play the game until they broke through every obstacle and reached the end of the game, and in so doing achieve mastery of the target content?

**Learning content of monopoly game**

The main topic of the learning content in this study was the area of a circle. This topic covered five concepts: Estimating a circle, the formula to calculate the area of a circle, sector and central angles, leaf area, and the application of sector area method (Fig. 2).

The remedial instruction was designed as a tree and was assigned to students accordingly. Figure 2 presents the learning tree in which branch A is the estimation of a circle (hereafter designated as A), sub-branch A1 is the area of a leaf (hereafter designated as A1), sub-branch A2 is the area of a circle (hereafter designated as A2), and so on. Following completion of A1 and A2, students proceed to topic A. Because both A1 and A2 each have several groups of questions from which to randomly draw, no other questions are selected from A1 or A2 once the students have completed these categories. Instead, the game selects questions from category A or from categories B, C, D, and E. The students complete the unit on the "area of a circle" when each of the concepts, ABCDE, has been completed.
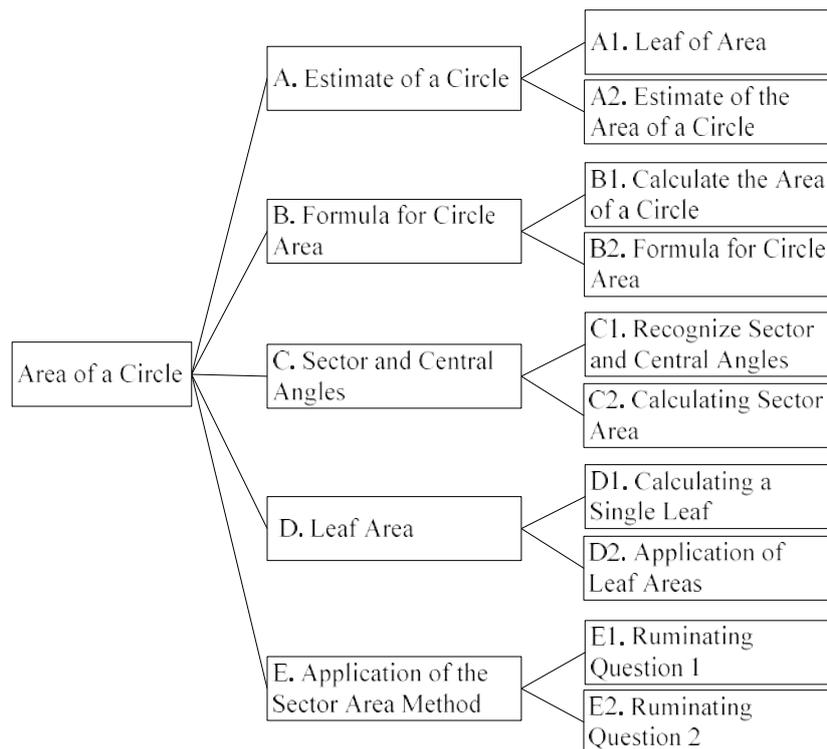


*Figure 2*. Learning tree for the "area of a circle" unit

**Monopoly game**

The player rolls dice to determine how students can move forward. Each location on the gameplay map corresponds to a question category. Figure 3 shows the game played by the experimental group. The left side of the game

illustrates the Monopoly gameplay map (virtual board) and the player's avatar. The right side of the game is a panel containing (from top to bottom): (1) the student's ID number, (2) the playing time, (3) game progress, (4) the list of previously studied topics, (5) buttons to roll the dice and control the video player, and (6) a real-time ranking list, which is refreshed every 5 minutes.
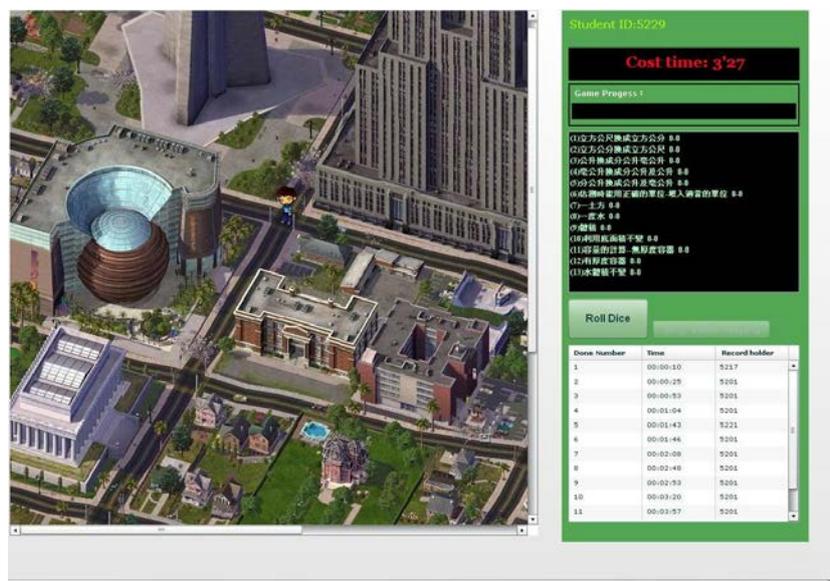


*Figure 3.* The "Monopoly" game for the experimental group

After clicking on the ROLL DICE button, the avatar moves to a new location corresponding to the number rolled, whereupon a question appears. A sample question is shown in Figure 4. The player must enter the correct answer in the input box located at the bottom of the screen. The category of the question is "measuring the area for different shapes." For example, the shapes formed by the intersections of circles with rectangles, arcs, and lines, as well as irregular shapes such as backyards, the country of Taiwan, and leaves. When the player answers the question correctly, he/she can continue playing the game by clicking the 'Roll Dice' button. The types of questions in the study include multiple-choice and open-ended items, where the students enter a random number in the space provided.
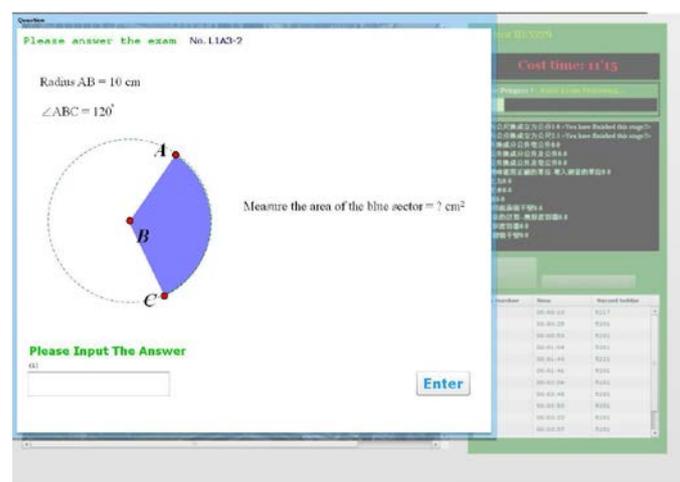


*Figure 4.* Interface for questions and answering questions

If the player answers the question incorrectly, the game is paused and an instructional video is initiated. The player can control the video playback using three buttons: "Play," "Pause," and "Stop." Manipulating the triangular marker above the three buttons enables the player to watch the video from a specific place (Fig. 5). If the player believes that

he/she can understand the content, they may stop the video at any time by clicking the "Stop Video Playing" button located on the right-hand side and clicking the 'Roll Dice' button to continue playing their game. The videos for students in the experimental group were the same as those used for the control group. In the experimental group, the video appears when the student triggers particular events in the Monopoly game; however, students in the control group can decide when to watch the instructional videos.
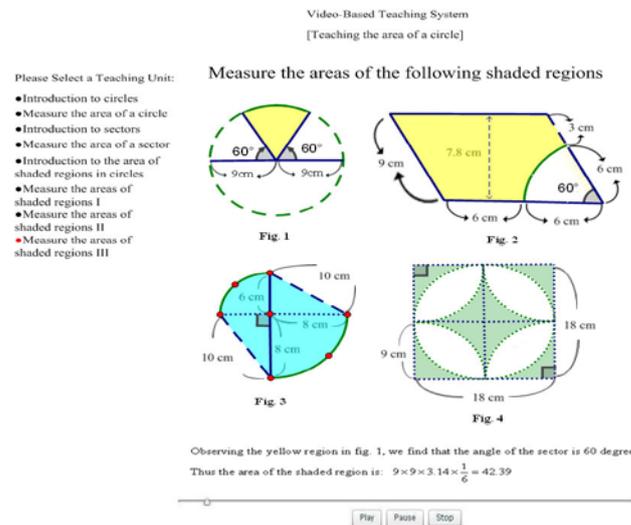


*Figure 5.* Example instructional video

## Results

### Does the use of instructional video enhance mastery learning?

Table 1 shows that a significant difference was found between the pre-test (M = 59.00, SD = 17.21) and post-test (M = 64.69, SD = 15.74) in the control group ($t$ = -2.06, $p$ < .001). This suggests that the integration of an instructional video based on the concept of mastery learning is beneficial for students learning mathematics.

*Table 1.* Pretest and posttest results for the control group

|          | N  | M     | SD    | t         |
|----------|----|-------|-------|-----------|
| Pretest  | 32 | 59.00 | 17.21 | -2.06***  |
| Posttest | 32 | 64.69 | 15.74 |           |

*Note.* ***P < .001.

### Does the use of the game, monopoly, enhance the success of mastery learning?

As shown in Table 2, following completion of the Monopoly game, the average score of students increased from 60.33 (pretest) to 72.80 (posttest). A paired-sample t-test was conducted to compare pre-test and post-test scores. A significant difference was observed ($t$ = -7.42, $p$ < .001). This result indicated that the instructional video significantly enhanced the success of mastery learning.

*Table 2.* Pretest and posttest results for the experimental group

|                   | Average | Individuals | Standard Deviation | t         |
|-------------------|---------|-------------|--------------------|-----------|
| Pretest Results   | 60.33   | 30          | 18.68              | -7.42***  |
| Posttest Results  | 72.80   | 30          | 19.55              |           |

*Note.* ***p < .001.

**Comparison of monopoly and instructional video in the enhancement of mastery learning**

Analysis and comparison of pretest and posttest results for the control and experimental groups are as follows:

*Comparison of test scores for both groups prior to the exercise*

According to the data presented in Table 3, the pretest scores for the experimental group and the control group were close ($t = .43$, $p = .35 > .05$), indicating that prior to the remedial learning activity, students in both groups had similar mathematical knowledge.

Table 3. Independent samples t-test of the pretest assessment results

| Group | N | Mean | SD | *t* |
|---|---|---|---|---|
| Control Group | 30 | 61.09 | 18.05 | .43 |
| Experimental Group | 32 | 59.24 | 17.00 | |

*Comparison of posttest scores for both groups following the exercise*

According to the data presented in Table 4, there is a significant difference in the posttest scores between the experimental and control groups ($t = -1.81$, $p < .05$). Furthermore, the mean posttest score of the experimental group was significantly higher than that of the control group, indicating that students who received game-based remedial instruction outperformed those who received only video-based remedial instruction.

Table 4. Independent samples t-test of the posttest assessment results

| Group | Individuals | Mean | Standard Deviation | *t* |
|---|---|---|---|---|
| Control Group | 32 | 64.69 | 15.74 | -1.81* |
| Experimental Group | 30 | 72.80 | 19.55 | |

*Note.* *$p < .05$.

## Conclusions and discussion

The aim of this study was to compare the effectiveness of game-based and video-based remedial instruction on mathematics performance. The results indicate that both forms of remedial instruction have a positive influence on learning performance. These results support the findings in previous studies (Choi & Johnson, 2005; Papastergiou, 2009). This study demonstrated the effectiveness of applying multimedia devices, such as computer games or videos, to the task of learning mathematics. Few previous studies have addressed the issue of game-based remedial instructions. Tsuei (2009) proposed the G-Math Peer-Tutoring System, which is a multiplayer environment designed to facilitate the peer-tutoring activities of elementary students associated with remedial instruction. Four students with low achievement in mathematics participated in the study for four months, and their improvements demonstrated the effectiveness of this approach. Unlike the collaborative learning approach employed by the G-Math Peer-Tutoring System, students in this study faced problem-solving situations on their own. Students who participated in the Monopoly game could not proceed without watching an instruction video pertaining to the unit with which the students had difficulty. The students were forced to solve the problem before proceeding, which is the essence of mastery learning. Computer-based mastery learning can increase the level of proficiency when students study the unit on the "area of a circle."

We found that an integration of mastery learning strategies with game-based learning provides greater benefits for students learning mathematics. When designing digital games for educational purposes, it is important to align the content and learning strategies with the structure of the game (Lin & Liu, 2009). To more effectively integrate mastery learning strategies into game-based remedial instruction, we divided the learning material into several small units to reduce the complexity of individual units. In addition, the system provides students with analytical information related to their learning outcome in each unit. This feedback enables students to monitor their own learning, and to identify their weaknesses in each of the learning units. Furthermore, the full impact of the

multimedia experience and attractive graphics (essential elements of digital games) was fully exploited to enhance the experience of flow and engagement in the learning activities (Chuang & Chen, 2009).

Finally, we identify a number of issues related to game-based remedial instruction for future study. First, investigating the effectiveness of game-based remedial instruction on learning motivation and attitudes related to math learning remains an important issue for future studies. Second, a longitudinal study could be conducted to investigate the effectiveness of game-based instruction for remedial purposes. Finally, it is necessary to determine whether game-based remedial instruction is suitable for other disciplines, such as language learning and computer science.

## Acknowledgements

## References

Anderson, J. R. (2000). *Learning and memory: An integrated approach* (2nd ed.). New York, NY: John Wiley and Sons.

Bloom, B. S. (1968). Learning for mastery. *Evaluation Comment, 1*(2), 1-5.

Bloom, B. S. (1981). *All our children learning*. New York, NY: McGraw-Hill.

Bowen, D. E. (2008). *Implementation of mastery learning in online undergraduate math courses: A comparative analysis of student satisfaction, retention rates, and academic achievement.* (Unpublished doctoral dissertation). Fielding graduate University, Santa Barbara, California.

Carroll, J. B. (1963). A model of school learning. *Teachers college record, 64*(8), 723-733.

Chang, K. E., Wu, L. J., Weng, S. E., & Sung, Y. T. (2012). Embedding game-based problem-solving phase into problem-posing system for mathematics learning. *Computers & Education, 58*(2), 775-786.

Changeiywo, J. M., Wambugu, P. W., & Wachanga, P. W. (2011). Investigations of students' motivation towards learning secondary school physics through mastery learning approach. *International Journal of Science and Mathematics Education, 9*(6), 1333-1350.

Charlton, B., Williams, R. L., & McLaughlin, T. F. (2005). Educational games: A technique to accelerate the acquisition of reading skills of children with learning disabilities. *The International Journal of Special Education, 20*(2), 66-72.

Chiang, Y. T., Lin, S. S. J., Cheng, C. Y., & Liu, E. Z. F. (2011). Exploring online game players' flow experiences and positive affect. *Turkish Online Journal of Educational Technology, 10*(1), 106-114.

Choi, H. J., & Johnson, S. D. (2005). The effect of context-based video instruction on learning and motivation in online courses. *The American Journal of Distance Education, 19*(4), 215-227.

Chuang, T. Y., & Chen, W. F. (2009). Effect of computer-based video games on children: an experimental study. *Educational technology & society, 12*(2), 1-10.

Davis, D., & Sorrell, J. (1995). Mastery learning in public schools. *Educational Psychology Interactive.* Valdosta, GA: Valdosta State University. Retrieved August 7, 2010, from http://teach.valdosta.edu/whuitt/files/mastlear.html

Ebner, M., & Holzinger, A. (2007). Successful implementation of user-centered game based learning in higher education: An example from civil engineering. *Computers & Education, 49*(3), 873-890.

Francis, P., Figl, C., & Savage, C. (2009, September). *Mastery learning in a large first year physics class*. Paper presented at the UniServe Science Conference 2009, Sydney.

Frederick, P. (2010). *Using digital game-based learning to support vocabulary instruction for developmental reading student*s. Unpublished doctoral dissertation. Nova Southeastern University, Davie, Florida.

Gee, J. P. (2007). *Good videogames and good learning: Collected essays on video games*. New York, NY: Peter Lang Publishing.

Guskey, T. R. (2007). Closing achievement gaps: Revisiting Benjamin S. Bloom's "learning for mastery." *Journal of Advanced Academics, 19*(1), 8-31.

Guskey, T. R., & Gates, S. L. (1986). Synthesis of research on the effects of mastery learning in elementary and secondary classrooms. *Educational Leadership, 43*(8), 73-80.

Holmes, W. (2011). Using game-based learning to support struggling readers at home. *Learning, Media and Technology, 36*(1), 5-19.

Hwang, G. J., & Wu, P. H. (2012). Advancements and trends in digital game-based learning research: A review of publications in selected journals from 2001 to 2010. *British Journal of Educational Technology, 43*(1), E6-E10.

Ke, F. F. (2008). A case study of computer gaming for math: Engaged learning from gameplay? *Computers & Education, 51*(4), 1609-1620.

Kebritchi, M., & Hirumi, A. (2008). Examining the pedagogical foundations of modern educational computer games. *Computers & Education*, 5(4), 1729-1743.

Lalley, J. P., & Gentile, J. R. (2009). Classroom assessment and grading to assure mastery. *Theory Into Practice, 48*, 28-35.

LeJeune, N. (2010). Contract grading with mastery learning in CS1. *Journal of Computing Sciences in Colleges, 26*(2), 149-156.

Liao, Y. K. (2010). Game-based learning vs. traditional instruction: A meta-analysis of thirty-eight studies from Taiwan. In D. Gibson & B. Dodge (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2010* (pp. 1491–1498). Chesapeake, VA: AACE.

Lin, C. H., & Liu, E. Z. F. (2009). A comparison between drill-based and game-based typing software. *Transactions on Edutainment III, Lecture Notes in Computer Science, 5940*, 48-58.

Liu, E. Z. F. (2011). Avoiding internet addiction when integrating digital games into teaching. *Social Behavior and Personality: An International Journal, 39*(10), 1325-1336.

Liu, E. Z. F., & Lin, C. H. (2009). Developing evaluative indicators for educational computer games. *British Journal of Educational Technology*, *40*(1), 174-178.

Liu, T. Y., & Chu, Y. L. (2010). Using ubiquitous games in an English listening and speaking course: Impact on learning outcomes and motivation. *Computers & Education, 55*(2), 630-643.

Lo, J. J., Wang, H. M., & Yeh, S. W. (2004). Effects of confidence scores and remedial instruction on prepositions learning in adaptive hypermedia. *Computers & Education, 42*(1), 45-63.

Marshall, P. A. (2009). Mastery learning in a sophomore level genetics course using the blackboard course shell. *Journal of the Arizona-Nevada Academy of Science, 41*(2), 55-58.

O'Neil, H., Wainess, R., & Baker, E. V. (2005). Classification of learning outcomes evidence from the computer games literature. *Curriculum Journal, 16*(4), 455-474.

Papastergiou, M. (2009). Digital game-based learning in high school computer science education: Impact on educational effectiveness and student motivation. *Computers and Education, 52*(1), 1-12.

Prensky, M. (2003). Digital game-based learning. *ACM Computers in Entertainment, 1*(1), 1-4.

Ritchie, D., & Thorkildsen, R. (1994). Effects of accountability on students' achievement in mastery learning. *Journal of Educational Research, 88*(2), 86-90.

Sedaghat, A. M., Mintz, S. M., & Wright, G. M. (2011). Using video-based instruction to integrate ethics into the curriculum. *American Journal of Business Education, 4*(9), 57-76.

Sancho, P., Moreno-Ger, P., Fuentes-Fernandez, R., & Fernandez-Manjon, B. (2009). Adaptive role playing games: An immersive approach for problem based learning. *Educational Technology & Society, 12*(4), 110-124.

Seonju, K. (2002). An empirical analysis of children's thinking and learning in a computer game context. *Educational Psychology, 22*(2), 219-233.

Shih, J. L., Shih, B. J., Shih, C. C., Su, H. Y., & Chuang, C. W. (2010). The influence of collaboration styles to children's cognitive performance in digital problem-solving game "William Adventure": A comparative case study. *Computers & Education, 55*(3), 982-993.

Susaeta, H., Jimenez, F., Nussbaum, M., Gajardo, I., Andreu, J. J., & Villalta, M. (2010). From MMORPG to a classroom multiplayer presential role playing game. *Educational Technology & Society, 13*(3), 257-269.

Tsuei, M. P. (2009). *The G-math peer-tutoring system for supporting effectively remedial instruction for elementary students.* Paper presented at the Ninth IEEE International Conference on Advanced Learning Technologies, Riga, Latvia.

Tüzün, H., Yılmaz-Soylu, M., Karakuş, T., İnal, Y., & Kızılkaya, G. (2009). The effects of computer games on primary school

students' achievement and motivation in geography learning. *Computers & Education, 52*(1), 68-77.

Virvou, M., Katsionis, G., & Manos, K. (2005). Combining software games with education: Evaluation of its educational effectiveness. *Educational Technology & Society, 8*(2), 54-65.

Wambugu, P. W., & Changeiywo, J. M. (2008). Effects of mastery learning approach on secondary school students' physics achievement. *Journal of Mathematics, Science & Technology Education, 4*(3), 293-302.

Yang, Y. F. (2010). Developing a reciprocal teaching/learning system for college remedial reading instruction. *Computers & Education, 55*(3), 1193-1201.

Yildiran, G., & Aydin, E. (2005). The effects of mastery learning and cooperative, competitive and individualistic learning environment organizations on achievement and attitudes in mathematics. *Journal of the Korea Society of Mathematical Education Serious D: Research in Mathematical Education, 9*(1), 55-72.

Yien, J. M., Hung, C. M., Hwang, G. J., & Lin, Y. C. (2011). A game-based learning approach to improving students' learning achievements in a nutrition course. *The Turkish Online Journal of Educational Technology, 10*(2), 1-10.