International Journal of Human–Computer Interaction

ISSN: 1044-7318 (Print) 1532-7590 (Online) Journal homepage: www.tandfonline.com/journals/hihc20

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To cite this article: Yu-chu Yeh, Jui-Yen Chang & Yu-Shan Ting (2023) Engaging Elementary School Children in Mindful Learning Through Story-Based Creativity Games Facilitates Their Growth Mindset, International Journal of Human–Computer Interaction, 39:3, 519-528, DOI: 10.1080/10447318.2022.2041901

To link to this article: https://doi.org/10.1080/10447318.2022.2041901

INTERNATIONAL JOURNAL OF HUMAN–COMPUTER INTERACTION
2023, VOL. 39, NO. 3, 519–528
https://doi.org/10.1080/10447318.2022.2041901

Engaging Elementary School Children in Mindful Learning Through Story-Based Creativity Games Facilitates Their Growth Mindset

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ABSTRACT

A growth creativity mindset is critical to the learning of creativity which is regarded as an important future skill. To cultivate such a positive belief and to understand what mechanisms may help improve growth mindset among children, we developed a story- and game-based learning system for creativity training, through which a five-class experimental instruction was conducted. Specifically, we aimed to examine the learning effect of growth creativity mindset and the relationship between mindful learning, mastery experience, and growth creativity mindsets in the context of game-based learning. Participants were 118 5th and 6th graders selected from six elementary schools in Taiwan. Led by a story called "*Treasure Hunt*," which takes place across seven countries, the participants were scaffolded through interdisciplinary learning covering geography and creativity. The concerned variables were measured by 6-point Likert-type scales. Results of repeated measure analysis of variance revealed that the students' perceived growth-external control mindset, but not the growth-internal control mindset, was significantly enhanced after the game-based learning. Moreover, a path model analysis indicated that mastery experience acts as a mediator between mindful learning and growth creativity mindset (especially the growth-internal control mindset). The results suggest that game-based learning in the context of a story helps in engaging students in mindful learning, achieving mastery experience, and strengthening a growth creativity mindset. This study also demonstrates the possibility of interdisciplinary design in game-based learning. The success of intervention and the theoretical framework proposed in the study provide insights to creativity education and the design of game-based learning.

1. Introduction

Creativity mindset refers to beliefs about the nature of creativity, which influence the development of creativity (Fleck & Asmuth, 2021; Puente-Diaz & Cavazos-Arroyo, 2019). People with a growth creativity mindset believe that their creative ability can be developed through training and practice. In contrast, people with a fixed creativity mindset believe their creative abilities and their creative talents are fixed traits (Fleck & Asmuth, 2021; Karwowski, 2014; Karwowski et al., 2019; Puente-Diaz & Cavazos-Arroyo, 2019). Creativity has been defined as an important future skill for 2030 by the Organization for Economic Cooperation and Development (OECD) (OECD, 2021). A number of studies have obtained evidence for the valuableness and effectiveness of creativity training or interventions (e.g., Kim et al., 2019; Puccio et al., 2020; Ritter & Mostert, 2017). However, few studies have examined whether and how the intervention of creativity learning carries significant effects on the changes of creativity growth mindset during game-based learning.

Many studies have found that game-based learning can enhance attention, self-learning motivation, and positive learning outcomes (Brezovszky et al., 2019; Gil-Doménech & Berbegal-Mirabent, 2019; Khowaja & Salim, 2019; Park et al., 2019; Wu, 2018; Yeh et al., 2020). It has also been found that mindful learning helps improve attention, working memory, cognitive flexibility, and problem solving (Davenport & Pagnini, 2016; Langer, 2016; Ostafin & Kassman, 2012). Emphasizing mindful learning therefore contributes to the achievement of mastery experience during game-based creativity training (Yeh, Chang, et al., 2019). Notably, mastery experience (i.e., personal experience of success) is usually regarded as an important learning outcome (Bandura et al., 1999; Starks, 2014) and it contributes to the formation of self-efficacy (Bandura et al., 1999). Moreover, growth mindset and self-efficacy are found to be positively related (Karwowski, 2014; Karwowski & Kaufman, 2017). Enhancing mastery experience may therefore strengthen a growth mindset. In other words, a growth mindset belief built on mastery experience can be even more important because it helps promote continual self-improvement.

To date, although some researchers have developed training programs to promote students' creativity or have implemented game-based learning to enhance learning outcomes (e.g., Hoffmann et al., 2021; Hwang et al., 2017; Ritter et al., 2020; Sera & Wheeler, 2017; Stolaki & Economides, 2018), few

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researchers have focused on the learning effects of a growth mindset. Built on the aforementioned evidence and arguments regarding the possible impact of mindful learning and mastery experience on growth mindset, we postulated that a well-designed game-based creativity learning system would help facilitate mindful learning, which would further result in mastery experience and further strengthen the growth creativity mindset. Notably, it has been found that incorporating stories into game-based learning can make learning more enjoyable and effective for children (Yeh et al., 2020). To fortify the learning effect, we developed the "Digital Game-based Learning system of Creativity-level B" (DGLC-B) for upper graders (5th and 6th graders) in elementary schools. Through the DGLC-B, we conducted an experimental instruction to examine the learning effects of growth mindset as well as the mediation effect of mastery experience on mindful learning and growth mindset in game-based creativity learning.

2. Growth mindset, mindful learning, and mastery experience

2.1. Growth mindset of creativity

The mindset theory was created by discussions of peoples' implicit beliefs of intelligence (Bernecker & Job, 2019) by Dweck (2007). Mindset can be categorized into a growth mindset and a fixed mindset based on stability and malleability (Dweck, 2012). People who hold a growth mindset consider intelligence to be malleable and that it can be developed through practice or learning. In contrast, people who hold a fixed mindset consider intelligence to be unchangeable and innate (Limeri et al., 2020; Wilson & Conyers, 2020). More recently, the concept of mindset has been implemented in some creativity studies. Creativity mindset refers to beliefs or theories about the nature of creativity (Fleck & Asmuth, 2021; Puente-Diaz & Cavazos-Arroyo, 2019). People who hold a growth creativity mindset regard creativity as a changeable ability and therefore are willing to take on challenges and make efforts to improve self-creativity (Fleck & Asmuth, 2021; Puente-Diaz & Cavazos-Arroyo, 2019).

In previous studies of intelligence or creativity mindset, the major research stream is focused on the effect of the one-dimensional theory, which includes the growth mindset and the fixed mindset. On the basis of the evidence that mindset and locus of control are closely related (Burgoyne et al., 2018; Stern, 2015); and Yeh et al. (2020) developed a two-dimensional theory of creativity mindset, in which a 6-point inventory was constructed. With the dimensions of "learning plasticity" and "locus of control," they identified four types of creativity mindset: growth-internal control, fixed-internal control, growth-external control, and fixed-external control. In this study, we focused on the two types of growth mindset. Growth-internal control mindset refers to the belief that creativity can be improved through self-learning, whereas growth-external control mindset refers to the belief that creativity can be improved with good learning environments or through others' help. In this study, we used the subtests of growth-internal control and growth-external control to measure the participants' growth mindset of creativity.

It has been found that creativity growth mindset helps in the construction of a framework for digital game-based learning for the development of mastery experience (Behnamnia et al., 2020; Cutumisu, 2019; White & McCoy, 2019). Could it be the other way around? That is, could mastery experience help fortify growth mindset during game-based learning? This study seeks to answer this question.

2.2. Mindful learning

Mindfulness refers to a non-reactive awareness that involves paying attention purposely to the present moment and allowing experiences to unfold moment by moment (Barbezat & Bush, 2013; Kabat-Zinn, 2003; Maurits Kwee, 2015; Siqueira & Pitassi, 2016). Following the concept of mindfulness, Langer (2000) proposed that mindful learning involves a flexible state of mind in which people are context-sensitive and aware of things using original thoughts. In the same vein, Yeh, Chang, et al. (2019) suggested that mindful learning contributes to engagement in the present, sensitivity to the context, openness to new information, awareness of multiple perspectives, and emotional regulation. Empirical findings also indicate that mindful learning can improve individuals' motivation development, learning performance, ability to handle emotional and physical stress, as well as confidence in managing exams or related demands (Hassed & Chambers, 2014).

Researchers (e.g., Lin & Vartanian, 2018; Yeh et al., 2014, 2016) have indicated that creative thinking processes are significantly influenced by emotion, work memory, the generation of possible solutions, and the idea evaluation. Furthermore, it was found in a longitudinal experimental study that mindfulness could increase memory, positive affect, competence, and creativity (Langer, 2016). These findings demonstrate that cognitive processes of creativity are closely related to mindful learning. Additionally, it is suggested that game-based learning creates an environment with the potential to promote mindful learning (Sedig, 2008). To sum up, it is reasonable to speculate that mindful learning could be a significant antecedent variable during game-based learning for creativity training.

2.3. Mediation effect of mastery experience on mindful learning and growth mindset

Bandura et al. (1999) claimed that mastery experience can be achieved through four mechanisms: progressive goal setting, acquisition of required knowledge and skills, the practice of skills in diverse settings, and feedback on performance. Game-based learning incorporating these mechanisms is found to be effective in enhancing mastery experience and self-efficacy (Huang & Yeh, 2016). Other researchers (Yeh, Chang, et al., 2019) also suggest that providing the following aspects is important for enhancing mastery experience during game-based learning: immediate feedback, clear goals, and appropriate challenges, encouragement, free choice, and rewards.

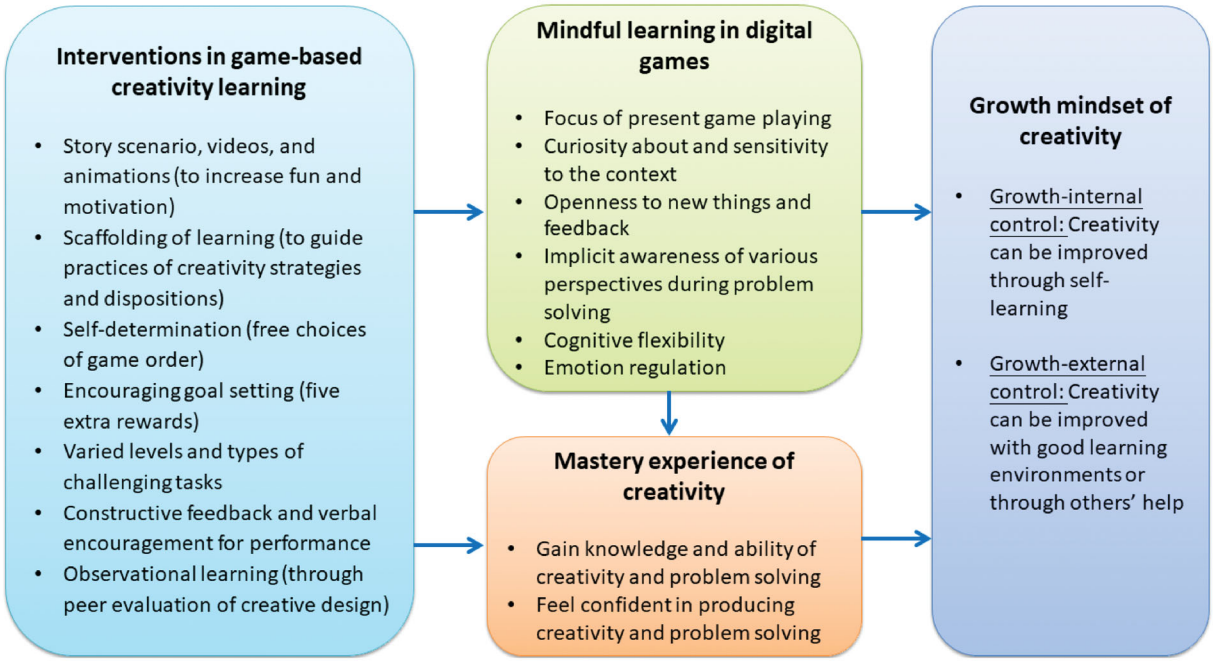

Figure 1. The theoretical framework of this study.

Mastery experience is a vital part of game-based learning. In this study, mastery experience of creativity refers to ability and confidence in solving problems during creativity game-based learning. In a game-based creativity study (Yeh, Chang, et al., 2019), it was found that mindful learning carried positive influence on mastery experience among 3rd and 4th graders, and mindful learning enhanced mastery experience through cognitive functions such as attention, cognitive flexibility, problem solving, positive emotion, working memory, and mindful practice of creativity skills. It was also found that mindful learning influenced mastery experience through flow experience and self-efficacy among 5th and 6th graders (Yeh, Chen, et al., 2019). When learning mindfully, learners are more prone to take multiple perspectives to find solutions that fit the context during the divergent thinking process (Langer, 1993). In addition, when mindful strategies are implemented, learners have more opportunities to exercise thinking skills, communication, and collaboration, thereby resulting in a better learning experience (Davenport & Pagnini, 2016; Halloluwa et al., 2014).

During game-based learning, the mastery experience built from mindful learning may fortify the feelings that creativity can be improved through learning and practice. Such feelings may further strengthen the growth creativity mindset. In other words, through the scaffolding of repeated guided practice and successful experience, the growth mindset of creativity may be significantly enhanced. Accordingly, mindful learning may directly influence mastery experience as well as indirectly influence growth mindset through mastery experience during game-based creativity learning.

2.4. The present study

This study aims to explore the relationship of 5th and 6th graders' (upper graders in elementary school) growth mindset, mindful learning, and mastery experience in game-based creativity learning, as well as to examine whether their growth mindset could be enhanced from such a learning process. To achieve our goals, we tried to integrate story scenarios and mechanisms to enhance mastery experience into a game-based learning system that comprises comprehensive skill and disposition training of creativity, through which we conducted an experimental instruction. Story-oriented learning increases children's immersion and motivation in learning (McGeown et al., 2020). We therefore included this feature in our learning system. Moreover, a path model analysis was employed to examine the mediation effect of mastery experience on mindful learning and growth mindset of creativity. Additionally, the change in growth creativity mindset after the game-based learning was examined. The theoretical framework integrated from the aforementioned literature is shown in Figure 1, and the following hypotheses were proposed:

- Learners' growth creativity mindset would be enhanced after completing the game-based creativity training.
- Learners' mastery experience would mediate the influence of mindful learning on creativity growth mindset at the end of the game-based creativity training. Specially, the learners' mindful learning would directly influence growth creativity mindset and indirectly influence their growth mindset through mastery experience.

3. Method

3.1. Participants

Using purposive sampling, we included 118 5th and 6th graders selected from six elementary schools in Taiwan. Among the participants, 63 were boys (53.4%), and 55 were girls (46.6%). This study was approved by the Institutional

Figure 2. Procedures and contents of the DGLC-B.

Review Board of the university where the research was conducted. Written informed consent was obtained from all participants' parents before the experiment. All participants were rewarded with a gift card valued at about 5 USD.

3.2. Instruments

3.2.1. Digital game-based learning of creativity

Adapted from the learning system of the "Digital Game-based Learning of Creativity" (Yeh, Chang et al., 2019), a more elaborated animation and interdisciplinary version—the "Digital Game-based Learning of Creativity-Level B" (DGLC-B) was developed for upper graders (5th and 6th graders) in elementary school. The DGLC-B comprises creativity training strategies for skills and dispositions. With the scenario of "Searching for Lost Treasures," the DGLC-B consists of an initial part (demographic information and a 3 D creative design task), a main part (seven games for enhancing skills or dispositions of creativity) and a final part (a 3D creative design task, performance feedback, and peer evaluation of creative design tasks) (see Figure 2). The main creativity dispositions and skills practiced included: positive thinking, thinking outside the box, divergent thinking, convergent thinking, observation, lateral thinking, and SCAMPER (see Figure 2). These strategies were practiced through 3D creative design, short video stories, open-ended questions, animations, multi-perspective thinking, observation, and problem-solving. Each game ranged from 10 to 15 min. Through finding seven lost treasures in seven countries, we also hoped the learners could learn the geography of these countries.

The introductory story was as follows: "*The seven treasures of the gods are missing! All the gods went to visit Zeus to ask for his help to get the treasures back. Dear students, you are the detectives entrusted by Zeus to go on a treasure hunt. Zeus will send Athena, the goddess of wisdom, to help you. When you encounter difficulties, you can call her name, and she will show up. The seven lost treasures were Athena's Aegis in Greece, the Magic Flying Carpet in the Arabian Peninsula, the Eye of Horus in Egypt, the Sibylline Books in Rome, the Gandiva in India, the Axe of Perun in Siberia, and the Kunlun Mirror in China. Maps of these countries will be shown in the game. You are about to start the adventure.*"

3.2.2. Inventories and the reflection questionnaire

All inventories employed in this study were 6-point Likert-type scales with response options ranging from "totally disagree" to "totally agree." Two subtests of growth mindset (six items) from the "Inventory of Creativity Mindset"

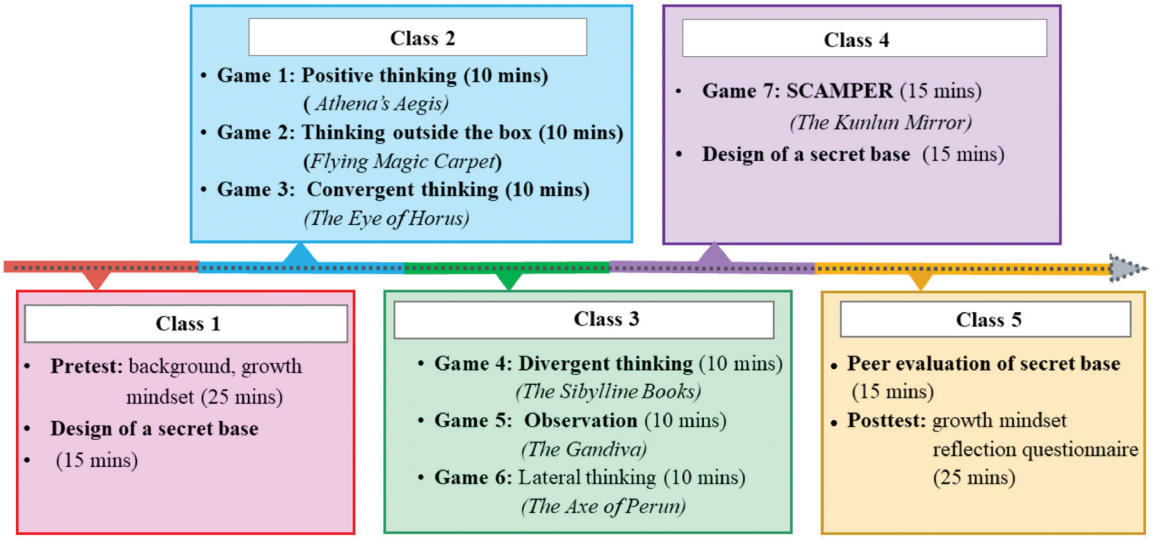

Figure 3. Procedures of experimental design.

Table 1. *Ms* and *SDs* in the reflection questionnaire.

Items	*M*	*SD*
1. I felt that this creativity game was interesting.	4.99	1.494
2. This creativity game increased my creativity.	4.88	1.474
3. The encouraging feedback given during the game playing enhanced my confidence.	4.87	1.482
4. The chance to receive a gift for a high score motivated me to try harder.	4.96	1.417
5. Being able to decide the game order by myself made the game more interesting, and it motivated me to move on to the next game.	4.90	1.527
6. The encouraging words given while answering questions made me more confident in accepting challenges.	4.59	1.223
7. The award for the best secret base design motivated me to work harder when creating my design.	4.53	1.295

(Yeh et al., 2020) were employed to measure the participants' growth mindset in this study. The two subtests were growth-internal mindset (GI) and growth-external mindset (GE); each of them included three test items. The test items for GI were as follows: (1) It is never too late to learn creativity, and creativity can be enhanced through self-learning. (2) I can improve my creative ability through self-learning. (3) I can be more creative as long as I am willing to learn. The test items for GE were as follows: (1) My creativity can be improved with the help of good teachers. (2) I am willing to learn creativity and I can become more creative when there is a good learning environment. (3) My creativity can be substantially improved when I have sufficient learning opportunities. The Cronbach's α for the overall growth mindset, GI and GE, were .873, .823, and .824. The correlation between GI and GE was .658 (Yeh et al., 2020). Since it has been found that a creative mindset and creative self-efficacy are closely related (e.g., Hass et al., 2017; Puente-Díaz & Cavazos-Arroyo, 2017), we used creative self-efficacy as the criterion variable and analyzed the correlation between GI, GE, and creative self-efficacy ($N = 118$, $rs = 730$ and .621, $ps < .001$); the results suggest that GI and GE have good criterion-related validity.

The "Inventory of Mindful Learning Experience in Digital Games" (IMLE-DG) was employed to measure the participants' experience of mindful cognition and emotion during game playing. The IMLE-DG included three factors: curiosity and open-mindedness (three items), attention and grit (four items), and emotional regulation (seven items). The Cronbach's α coefficient for the IMLE-DG and the three factors were .974, .947, .955, and .971, respectively. The test items included statements such as, "When playing the game, I had an open mind to think about all the possible ways to level up or complete tasks in the game"; "When playing the game, I liked challenging myself to complete the levels or tasks"; and "when playing the game, I could hold back sadness and encourage myself not to get rejected when I could not level up." (Yeh, Chang, et al., 2019; Yeh, Chen, et al., 2019).

The Inventory of Mastery Experience in Creativity Digital Games (IME-CDG) was used to measure the participants' level of mastery experience after playing the creative games. The IME-CDG includes two factors: ability to solve problems (five items) and confidence in solving problems (three items). The Cronbach's α coefficients for the IME-CDG and the two factors were .903, .860, and .819, respectively. The test items included statements such as "I can think of solutions quickly" and "I am confident in my abilities to develop creative ideas and solving problems" (Yeh & Lin, 2018, Yeh, Chang et al., 2019). Finally, 7 reflection questions were employed to understand all participants' attitudes toward game-based creativity learning (see Table 1 for the items).

3.3. Experimental design and procedures

All participants completed the experimental instruction at their schools during a flexible learning time or a computer class under the guidance and assistance of their class teachers. To minimize interferences on the participants, neither the homeroom teacher nor the researcher was there.

The participants were informed that the experiment had nothing to do with their grades; however, there would be a gift card when they completed the experiment. All participants completed the DGLC-B experimental procedures throughout five classes (40 min for each class) within two weeks. In class 1, the participants completed the inventories regarding background information and growth mindset. They also completed the first 3D creative design of their own secret base. In classes 2 through 4, they completed the seven games in the DGLC-B as well as the second 3D creative design of a secret base. In class 5, they first competed the peer evaluation of the two 3D creative design products. Then, they completed the posttest of growth mindset, the mastery experience inventory, and the reflection questionnaire (see Figure 3).

Additionally, to enhance learning effects, each participant was informed at the beginning of the experiment procedure that top scores obtained from the game could receive an extra gift card valued at about 5 USD. Immediate feedback regarding their score in each game was also displayed at the end of each game. In general, the DGLC-B incorporated many teaching strategies to enhance learning effects, such as providing scaffolding to learn advanced creativity skills, offering chances for self-determination, giving constructive feedback for answers, giving immediate feedback regarding obtained scores, providing verbal encouragement for performance, and providing opportunities for observational learning from peer evaluation of the creatively designed products.

4. Results

4.1. Attitude toward the game-based learning experience

Seven reflection questions were employed to understand all participants' attitudes toward game-based creativity learning. The results indicate that the participants responded positively toward the learning and design of the DGLC-B. The *Ms* and *SDs* are shown in Table 1.

4.2. Preliminary analysis and improvement of growth creativity mindset

At the end of the game-based learning, we measured the concerned variables. The mean score of mindful learning was 4.94 ($SD = 1.10$), and that of mastery experience was 4.67 ($SD = 1.27$) in the 6-point Likert scale, revealing that the participants demonstrated a decent level of mindful learning and mastery experience during the game-based learning. The pretest and posttest scores of growth mindset are depicted in Figure 4. To examine the first hypothesis, we conducted a repeated measure analysis of variance to examine whether the participants enhanced their growth mindsets (GI and GE) after the game-based creativity learning. The results revealed that the participants' GE had significantly leveled up, $F(1, 117) = 6.287$, $p = .014$ $\eta^2_p = .051$, whereas their GI did not show significant improvement although the participants scored higher after the game-based learning, $F(1, 117) = 2.154$, $p = .145$, $\eta^2_p = .018$ (see Figure 2 for *Ms* and *SEs*).

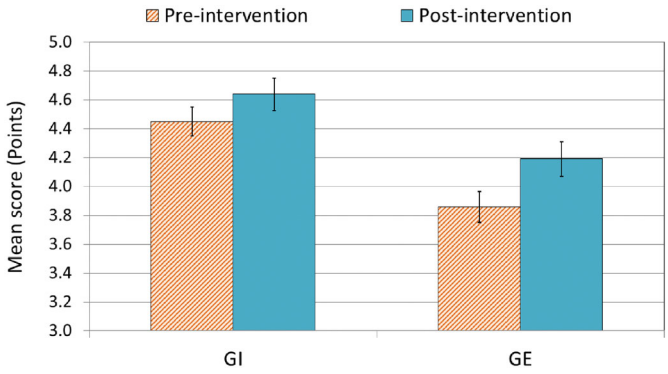

Figure 4. The Means and Standard deviations for the measured variables.

4.3. Path model results

Results of path model analysis through AMOS 21 showed that the model was close to a good-fit model, χ^2 ($N = 118$, $df = 11$) = 20.765, p = .036. However, the other indices were good: the goodness-of-fit index = .954, the adjusted goodness-of-fit index = .883, the root mean square residual = .026, the root mean square error of approximation = .087, the normed fit index = .976, the incremental fit index = .988, and the comparative fit index = .988. The results indicated that mindful learning during the game-based learning had a direct influence on growth creativity mindset, as well as an indirect influence on growth creativity mindset through mastery experience (see Figure 5).

All direct effects were significant. However, the direct effect of mindful learning on mastery experience was higher than that on growth creativity (.811 versus .505, $ps < .001$). The indirect effect of mindful learning on the latent variable of growth creativity mindset was .294, and the effects on the indices of GI and GE were .684 and .516 ($ps < .001$). Finally, the total effect of mindful learning on the latent variable of growth creativity mindset was .799 (.505 + .294) ($p < .001$), and the effects on the indices of GI and GE were also .684 and .516 ($ps < .001$).

5. Discussion

A growth creativity mindset is critical to the development of creativity (Fleck & Asmuth, 2021; Li et al., 2021; Puente-Diaz & Cavazos-Arroyo, 2019). In addition, mindful learning and game-based learning may help motivate students during training processes. To date, no study has investigated whether digital game-based creativity learning can enhance elementary school students' creativity mindset through the enhancement of mindful learning and mastery experience. Because games, especially those with stories, provide a great tool for children's learning (Yeh et al., 2020), this study developed a story- and game-based creativity training system incorporating mechanisms that enhance mindful learning and mastery experience. We hoped that such a design would bring about the improvement of growth creativity mindset.

Two hypotheses were proposed in this study. The first hypothesis was partially supported. Specifically, we found

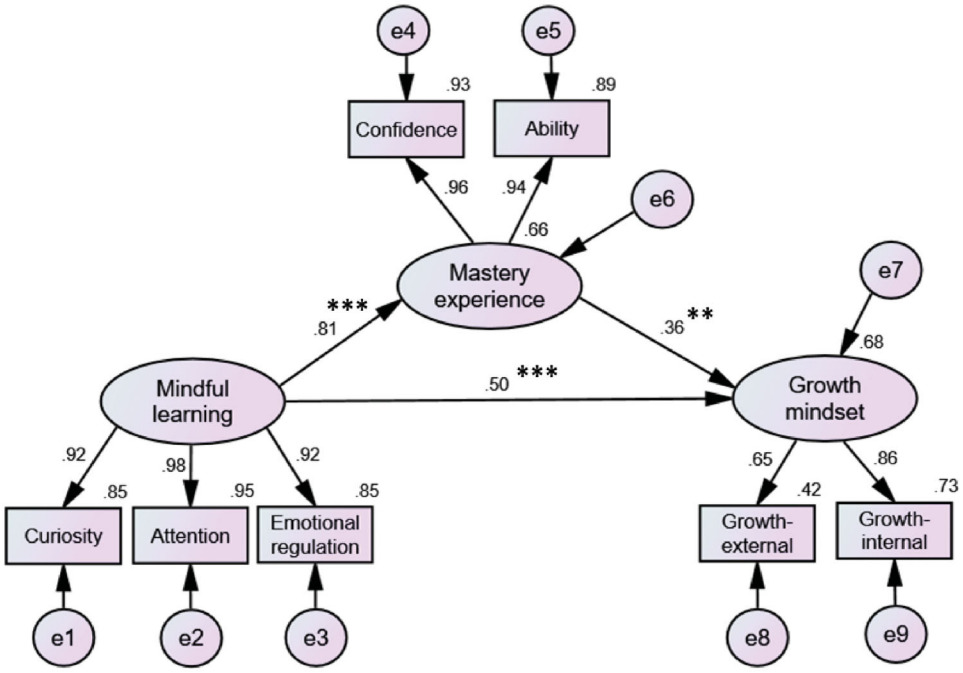

Figure 5. Results of the proposed path model.

that the students' growth-external mindset, but not growth-internal mindset, was significantly enhanced after the game-based learning. The growth-internal mindset involves self-learning, whereas the growth-external mindset concerns external support from environments or teachers. The results revealed that, although the students learned by themselves through the guidance provided during game playing, they seemed to perceive such a learning opportunity as external support. It also makes sense because the teacher helped them during the process. Nevertheless, the participants' growth-internal mindset had increased after the game-based learning. This finding suggests that elementary school students are less confident in self-learning, and it is hard to change such a belief. Overall, the results here are in line with past findings that employing digital games as learning tools for creativity training can stimulate students' learning motivation, knowledge transfer, acquisition of skills in digital experience, higher-order thinking skills, and a positive attitude toward learning, and it can provide deep, insightful learning (Bai et al., 2012; Behnamnia et al., 2020; Behnamnia, Kamsin, & Ismail, 2020; Hsiao et al., 2014; Kim & Chang, 2010; Yang, 2012; Yeh, Chang, et al., 2019, Yeh, Chen, et al., 2019).

Additionally, our hypothesis regarding the path model was supported by the results showing that the proposed path model, in general, was a good fit model, in which mastery experience acts as a mediator between mindful learning and growth creativity mindset. Moreover, mindful learning has a direct influence on growth creativity mindset. The results lend support to the finding that there are close associations between creativity mindset and mindfulness/mindful learning (Gadhavi & Sahni, 2020; Hassed & Chambers, 2014; Henriksen et al., 2020), between mindful learning and mastery experience (Yeh, Chang, et al., 2019), and between mastery experience and mindset (Song et al., 2019; Yeh, Chang, et al., 2019). To date, little empirical evidence has been presented on how mindful learning enhances growth mindset during game-based learning. Our findings support the notion that mindful learning helps students pay attention, improves their cognitive flexibility, and increases their persistence in problem solving while completing scaffolded learning and practices. As a result, the students achieve mastery experience of creativity skills and strategies, which further fortifies their belief that creative ability can be improved through self-learning, others' help, or a rich environment. Interestingly, while the growth-external control mindset is significantly improved, the growth-internal mindset has a stronger association with mastery experience and mindful learning than the growth-external control mindset, suggesting that although the students are less confident about improving creativity through self-learning, their growth-internal control belief implicitly and closely interacts with mastery experience and mindful learning.

Moreover, the direct and indirect influence of mindful learning on the cultivation of growth creativity mindset supports our thoughts in conducting the experiment: a fundamental strategy for bringing about the improvement of growth mindset through game-based learning is encouraging students to learn mindfully and achieve mastery experience during game playing. To achieve this goal, we connected the games with story scenarios, videos, and animations to increase fun and learning motivation. Additionally, we provided scaffolding and varied challenging tasks to guide practices of creativity strategies and dispositions, allowed self-determination in game order, encouraged goal setting by giving extra rewards, gave constructive feedback and verbal encouragement for performance to enhance self-confidence and maintain mindful learning, and provided opportunities for observational learning through peer evaluation of creatively designed products. In addition, this study

incorporates the learning of geography through the treasure hunt in different countries. Such design helps in the acquisition of interdisciplinary knowledge, which is required for success in the twenty-first century. The positive responses from the reflection questionnaire and the learning effects found in this study all support the effectiveness of our design incorporated in the DGLC-B.

6. Conclusions

Because creativity is a crucial competence for future success, cultivating a growth creativity mindset helps children to continue self-learning and self-improving in creativity. We therefore developed the story- and game-based DGLC-B to enhance creativity skills and dispositions, hoping that the mastery of these fundamental elements would enhance a growth mindset of creativity. The results of the study suggest that the DGLC-B is an effective vehicle for such creativity training and a valid instrument for engaging elementary school students in creativity and interdisciplinary learning.

Most past studies have focused on how a growth mindset would influence mastery experience or a successful learning experience. This study, on the contrary, demonstrates how mastery experience can fortify a growth mindset. Specifically, this study goes beyond previous creativity and creativity mindset research in exploring how mindful learning can lead to the improvement of growth mindset through the scaffolding of mastery experience. Moreover, the influences of two types of growth creativity mindset (growth-internal versus growth-external) during game-based creativity learning are identified, which helps elucidate student's development of growth mindset and thereby helps inform design related instruction. To conclude, the success of the intervention employing the theoretical framework proposed in the study provides insight for rethinking the cause-and-effect relationship of influential variables during creativity training as well as the design of game-based learning aiming to improve creativity ability, growth creativity mindset, and interdisciplinary learning.

7. Limitations and implications

This study did not employ a control group because of limited available time and the learning equality issue, which was a concern of the cooperative schools. Nevertheless, the positive results found in this study were verified by triangulation data, including those collected from the inventories and the reflection questionnaire data. Further studies, if possible, can add a control group to replicate the findings as well as qualitative data (e.g., data from interviews or an open-ended questionnaire) to better understand the transformation of students' learning processes.

In addition, this study did not measure the states of mindful learning or mastery experience in the middle of the game-based learning because of the constraint of available time for the experiment. We therefore could not examine the dynamic relationship between mindful learning, mastery experience, and growth mindset. Understanding their dynamic relationship would provide more information about how to more effectively evolve growth mindset. Further studies are encouraged to apply dynamic assessment in such game-based training. Furthermore, to make the dynamic assessment more valid, a longer program may be required, if the sampled schools allow more time for experiment.

As for implications, this study found that while the growth-external control mindset had been improved more, the growth-internal control mindset was more connected with mindful learning and mastery experience. Such findings suggest that, from the viewpoint of elementary school children, support from teachers or the environment is critical to their formation of growth mindset, but their belief in their self-learning ability is more influential during game-based learning. Therefore, to cultivate young children's growth creativity mindset, teachers need to create the feeling of "with-it-ness" (the awareness of what is going on in all parts of the classroom at all times) and a positive environment for creativity learning. Meanwhile, strengthening the confidence of self-learning can be more specific during game-based learning.

Furthermore, the analytical results of this study suggest that mindful learning is a critical antecedent variable in game-based learning; it carries a significant impact on mastery experience and a perceived improvement in growth creativity mindset, especially that of growth-internal control mindset. Games or classroom teaching designed to enhance students' growth mindset should keep this in mind. The teaching strategies employed in this study can be valuable references. Important strategies include providing scaffolding to learn advanced creativity skills, offering chances for self-determination, giving constructive feedback for answers, giving immediate feedback regarding obtained scores, providing verbal encouragement for performance, and providing opportunities for observational learning from peer evaluation of creative design. Notably, this study incorporates the learning of geography into the learning of creativity, which demonstrates the possibility of interdisciplinary learning through game-based learning. Future design for game-based learning can take interdisciplinary learning into consideration to optimize the learning effects. Finally, the study initiates the study of how to indirectly enhance a growth mindset through game-based learning. Further studies can increase the time period for intervention and add direct interventions of growth mindset, such as introducing the concept of growth mindset and brain plasticity (how the brain can be changed).

Disclosure statement

No potential competing interest was reported by the authors.

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