

Influence of Game Quests on Pupils' Enjoyment and Goal-pursuing in Math Learning

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ABSTRACT

As a medium for learning, digital games provide promising possibilities to motivate and engage students in subject learning. In this study, a game-based learning system, My-Pet-My-Quest, is developed to support pupils' math learning. This is due to the fact that most students in Taiwan have relatively lower positive attitude towards math learning, even though their math performance is prominent. To this end, a three-tire framework is proposed to guide the design of the My-Pet-My-Quest system. A quasi-experiment was conducted to examine the influence of game quests on pupils' enjoyment and goal-pursuing in math learning. The results revealed that game quests were favored by students in terms of enjoyment, goal orientation, and goal intensity. Possible reasons for these results and a discussion of related issues are presented in this paper.

Keywords

Game-based learning, Game Quest, Goal-pursuing, Math learning

Introduction

Recently, game-based learning is regarded as a promising vehicle for facilitating students' active participation and engaged learning. On one hand, this is because digital games own a number of characteristics to engage students, such as imaginary, challenges, competition, fantasy, curiosity, uncertainty (Lo, Ji, Syu, You, & Chen, 2008), goal, decision, discussion, and emotional connection (Prensky, 2008). A well-incorporation of some of these characteristics might make a boring learning be interesting and joyful. On the other hand, different learning gains have been reported, including visual attention and spatial abilities (Barlett, Anderson, & Swing, 2009), problem-solving skill (Kiili, 2007), analogical reasoning (Williams, Yuxin, Feist, Richard, & Prejean, 2007), and subject matter mastery (Ricci, Salas, & Cannon-Bowers, 1996). These positive gains further foster the advocate of game-based learning.

Based on the two reasons, some work attempts to harness these game characteristics to design a learning environment that invites students to participate in learning tasks in a more enjoyable way. Two categories of approaches are emphasized: *game framework* and *blending approach*. The former makes good use of specific game genres to develop an architecture for game-based learning. This is due to the fact that some game genres involve game characteristics that could promote students' learning. For example, massively multiplayer online role-playing game (MMORPG) often involves quests and story-telling, which might be helpful to offer students a goal-oriented immersive learning environment (Dickey, 2007). In addition, the structure of adventure games could be helpful to students' hierarchical knowledge learning (Hu, 2008).

In addition to these game frameworks, a blending approach is also emphasized to integrate learning activities and digital games (Gunter, Kenny, & Vick, 2008) as a game-based learning environment, in which students apply learned knowledge for game progress. A typical example is WEST system (Burton & Brown, 1979), which embeds math calculation into a board game. More specifically, students compete against computers for reaching a specific destination to win the game by combining three numbers and two operators as forward steps. Moreover, several works also try to embed learning activities into different game genres, such as a collaboration game in the Prime Climb (Manske & Conati, 2005), and a Bingo game in the EduBingo (Chang, Ching, Cheng, Chang, Chen, Wu, & Chan, 2009).

Since game-based learning has been regarded as a potential way to motivate students to learn and different approaches have also been proposed in the aforementioned studies, it seems that classroom subject learning could be enhanced through game-based learning. In this paper, we emphasize primary education and choose math as the first subject to investigate. This is due to the fact that most students in Taiwan have relatively lower positive attitude (e.g., students' affect, value, and self-confidence) towards math learning, even though their math performance is prominent (Mullis, Martin, & Foy, 2008). In addition, if game-based learning could be applied to math learning successfully, game-based learning could also be applied to other subjects. In other words, our concern is not only how to use digital games to engage students in a joyful math learning experience, but also the flexibility of applying such learning environment to other subject learning.

To this end, the blending approach is used to develop a three-tier framework, in which domain-independent learning activities could be integrated with digital games. The intention of this framework is to maintain flexibility in dealing with different learning subjects. Moreover, based on this framework, we design a My-Pet-My-Quest system, which integrates a pet-nurturing game and a quest-delivery mechanism for math learning. This is because previous work has suggested that pet-nurturing games could be used to facilitate human-computer interaction for learning purpose (Chen, Deng, Chou, & Chan, 2007; Chen, Liao, Chien, & Chan, 2011). In addition, quest-delivery mechanism is regarded as a useful way to guide students to do tasks in role-playing games. We anticipate game quest also could be applied to subject learning, especially for increased perception of enjoyment and intention of goal-pursuing. More specifically, in this study, we focus on investigating the possibility and influences of quests on students' math learning through the My-Pet-My-Quest system. The research question of this paper is: *What are the influences of game quests on students' math learning in terms of perception of enjoyment and goal-pursuing.* We begin this paper by describing a three-tier framework, and then the development of a game environment, My-Pet-My-Quest, is presented next. Next, we proceed to discuss an empirical study on the influences of the game quest mechanism. Finally, some discussion and conclusion are drawn.

Three-tier framework

A three-tier framework proposed in this study is underpinned by a domain-independent approach. A major reason to adopt the domain-independent approach lies in the suggestion that two kinds of experts are required in the design of game-based learning (Norman, 1993), and the structure might help two kinds of experts work together. Game designers are the first experts who are good at advanced technology and know how to motivate students to learn something; the second one is domain experts who are skilled in pedagogies and know how to teach students well. A well-defined architecture or framework could be helpful to their communication and collaboration. As shown in Figure 1, the three-tier framework contains three tiers: learning activities (top tier), game world (bottom tier), and coupling mechanism (middle tier).

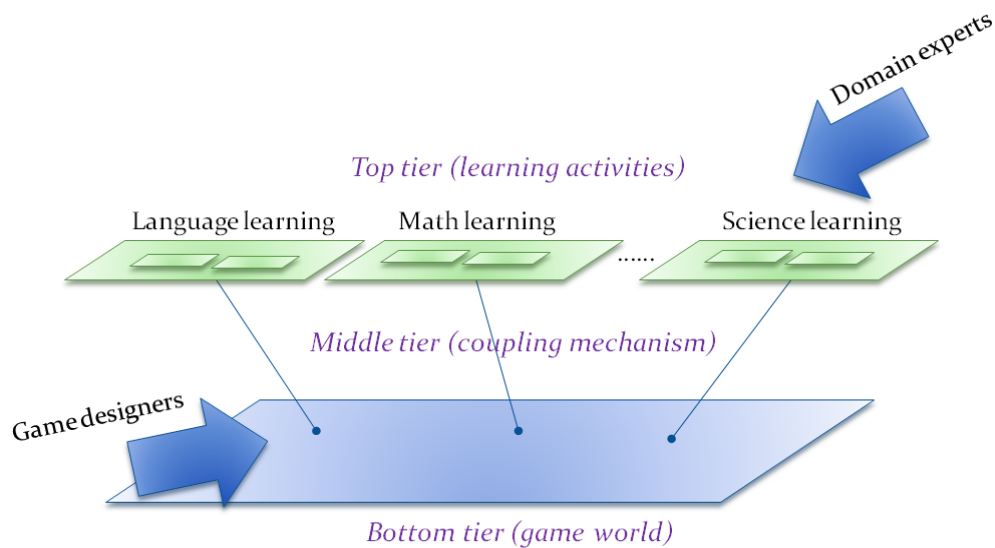


Figure 1. Conceptual diagram of three-tier framework

In terms of *game world* (bottom tier), the purpose of this tier is to stimulate and sustain students' participation motivation by providing them with the freedom of where to go, as well as the control over what to do. The design rationale behind is underpinned by the study of virtual worlds which offers fascinating opportunities to engage students in a non-traditional and large-scale environment (Feldon & Kafai, 2008). However, different game genres have varied game world settings. Some game genres, such as shooting game or fighting game, seldom focus on the existence of a game world, whereas the design of a game world matters in other games, such as role-playing game or adventure game. Therefore, the selection of game genres should concern the settings of game world, especially its impact on students' motivation stimulation and sustenance.

In terms of *learning activities* (top tier), the purpose of this tier is to embed different learning activities into a game world in a flexible but robust way. More specifically, the three-tier framework attempts to provide a domain-independent approach to blend a game environment with different learning activities, which could be easily designed as tasks with its pedagogies and learning goals, and then embedded into the game world. As mentioned above, such an approach might help facilitate the collaboration between game designers and domain experts, because domain experts could only focus on the design of learning activities, whereas game designers merely emphasize the development of the game environment.

In terms of *coupling mechanism* (middle tier), the purpose of this tier is to offer a goal-oriented mechanism to guide students to undertake learning tasks. This is due to the fact that a virtual learning environment could be a large-scale one, in which students might spend much time on basic system functions or task-unrelated works. In other words, to increase students' time on-task, it is required to develop some guiding mechanisms to anchor learning tasks for students. In a sense, the coupling mechanism could be regarded as a bridge that connects and facilitates the top tier and bottom tier. Learning activities (i.e., the top tier) could be embedded into the learning tasks to undertake by students through the coupling mechanism (i.e., the middle tier), and then appear in the game world (i.e., the bottom tier). The three tiers and their descriptions are summarized in Table 1.

Table 1. Three-tier framework and its purposes

<i>Tiers</i>	<i>Purposes</i>
Learning activities (Top tier)	To embed learning activities in different subject matters (e.g., language, math, and science learning) into the game world.
Coupling mechanism (Middle tier)	To provide students with a goal-oriented mechanism for guiding them to undertake learning tasks, increasing time on-task.
Game world (Bottom tier)	To stimulate and sustain students' participation motivation in learning activities through a virtual game world.

My-Pet-My-Quest System

A My-Pet-My-Quest system targeting elementary students as primary users is developed according to the three-tier framework. In particular, the My-Pet-My-Quest system embeds math learning into a pet-nurturing game, allowing for an investigation of the influence of the three-tier framework.

Pet-nurturing game (bottom tier)

The genre of pet-nurturing game is chosen as the game world setting in this study. This is because the following two reasons. The first reason is about the *stimulation* of students' motivation. Previous research has indicated that people, especially young students, have natural emotional attachments to their pets because the pets are simple, cute, and straightforward (Melson, 2001). Although what they mean are real pets, such emotional attachment also exists in the interaction with virtual pets (Kusahara, 2001). A typical example is Tamagotchi (Webster, 1998; Pesce, 2000), which are virtual pets that beep in several hours to ask students to feed them. When noticing the sound, the students can feed them virtual foods by pressing buttons. Although this interaction is quite simple, many children stay with them for a long period of time. This phenomenon implies that pet-nurturing might be helpful to stimulate students' motivation and facilitate interaction. This is the reason why we choose a pet-nurturing game as the game world.

The second reason is about the *sustenance* of students' participation. A pet-nurturing game often involves an economic process, *needs-consumption-work*. To take good care of the pets, students need to frequently check their needs. To satisfy their pets' needs, a number of pet food and goods are purchased (i.e., consumption). Thus, students are easily encouraged to do something, including learning tasks, for earning their pets' happy lives. Under such a structure, undertaking learning tasks could be regarded as "work." This metaphor is similar with the working model in our work-centered society (Ransome, 2005). When learning activities could be embedded into the economic process, it might be helpful to maintain students' participation motivation.

As depicted in Figure 2, the My-Pet-My-Quest system is developed, in which each student controls a *master avatar* who keeps a pet, My-Pet; thus, a major goal is to maintain the status of the pet. Each My-Pet has attributes, such as *energy* and *mood*, which are reflected in its status and can be improved through feeding and playing with My-Pet, respectively. In other words, when the student feeds the My-Pet, the "energy" attribute would be increased. Likewise, when the student plays with the My-Pet, the "mood" attribute would be increased as well. A student is therefore able to monitor achievement through the state of their pet, both in terms of happiness and healthiness.



Figure 2. Pet status is shown on the left, while quest locales are shown on the right

Learning activities (top tier)

The learning tasks that were implemented in My-Pet-My-Quest are according to the criteria of the national curriculum for third-grade elementary school mathematics. Each unit contains three types of learning tasks: *conceptual understanding*, *computational fluency*, and *problem solving*. Conceptual understanding and problem solving are presented in the form of page-turners. Students are presented examples and guidelines and are asked to respond. Figure 3(a) depicts a conceptual understanding task from the unit titled *Fractions*. In this example, students fill in the answers according to the number of cups in the illustration. Similarly, Figure 3(b) presents an example of problem solving from the unit titled *Multiplication*, in which students are asked to solve a combination word problem that requires both multiplication and addition operations.



Figure 3(a). An example of a conceptual understanding activity

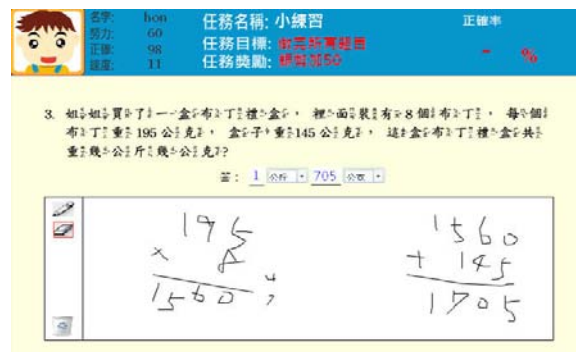


Figure 3(b). An example of a problem solving activity

Tasks for computational fluency take the form of mini-games and are used to consolidate students' computation skills in terms of both speed and accuracy. Figure 4 illustrates two mini-games. The mini-game on the left involves the addition of two three-digit numbers, while the mini-game on the right involves the multiplication of a two-digit number multiplied by a one-digit number. Solving these types of problems has been demonstrated to be beneficial for mathematics learning (Kilpatrick & Swafford, 2002).



Figure 4. Learning tasks for calculation fluency via mini-games

Quest mechanism (middle tier)

Game quest is selected as a guiding mechanism in the middle tier because of the following two advantages that it brings. The first advantage is to offer a *goal-oriented mechanism* to guide students to participate in learning activities within a game world. Quest-taking is a graceful way in role-playing games to lead students to conduct specific tasks. When students conduct the tasks they received from non-player characters (NPCs), they might feel that they have more controls and responsibility for the tasks, although the content of the tasks is actually the same. In other words, quest-taking might turn students' passive learning into active participation, because it offers students a clear and immediate goal to pursue. Thus, we use quest mechanism as a bridge between the bottom and top tiers.

The second advantage is to enhance the level of students' persistence by *social commitments*. The quests are often received from NPCs in the game world and it could, to some extent, be regarded as a process of negotiation between students and NPCs. Therefore, we argue that receiving quests from NPCs engenders a form of social commitment, which could enhance the intensity of goal-pursuing, especially in the sub-dimensions of *effort* and *persistence*, because it is significantly related to keeping ones promises and expectancies of success. Moreover, attributions of success (Weiner, 1985; 1992) and belief in ones efforts (Dweck, 2000) have substantial influences on learning, with the implication that efforts to learning and attitudes towards persistence have benefits due to the enhancement of convictions to do something. Thus, the social commitment to NPCs might be helpful of students, both for goal-setting and for task-driven intensity.

In My-Pet-My-Quest, a quest consists of three elements: *objectives*, *learning tasks*, and *rewards*. An objective offers students a clear goal; a learning task is the educational content of the quest; if students complete the learning task successfully, they gain rewards. For solving math problems, for example, a quest may involve an award of EduCoins, which are only awarded to those students who can master an arithmetic task by achieving more than 90% correct responses. In other words, when students successfully complete the quests, they are rewarded with EduCoins, which can be used to buy resources for the pets, such as pet food and goods.

Quests are conducted in a number of *locales*, such as a store, a forest, a tower, a temple, and an arena. The flow of game quests delivered by NPCs in My-Pet-My-Quest is described as follows. First, an *informer NPC* appears at the door to inform the student of new quests. The student can talk to the informer to obtain more detailed information, particularly the location on the island where a *quest NPC* waits to escort him to the quest, as depicted in Figure 5. A student clicks the button above an NPC, and the NPC tells him the content of the quest, including objective, learning tasks, and rewards. After receiving the instructions, the student commences the quest.



Figure 5. Quest NPCs providing information about quests

Methods

This study focuses on the research question: *how are the influences of game quests on students' subject learning in terms of perception of enjoyment and goal-pursuing*. To answer the question, a within-subjects experiment was conducted in an elementary school in Taiwan.

Participants

The participants in this experiment were 53 elementary students from two fourth-grade classes (median age: ten years old). In Class A there were 28 students, including 15 males and 13 females, while in Class B there were 25 students, including 14 boys and 11 girls. Since the elementary school has a policy of normal distribution at the start of the first, third, and fifth school year. Accordingly, it was assumed that the participations in each of the two groups have similar learning backgrounds and learning abilities, and that order effects have been controlled.

Instruments

Two system versions

Two different versions of the My-Pet-My-Quest system were prepared for the experiment: one with quests (i.e., *via-version*) and the other without quests (i.e., *without-version*). The two versions contain the same learning materials: two units of math activities in the mini-games about mastering the addition of two three-digit numbers. However, they are delivered to students by different ways.

With regard to the *via-version*, learning materials were delivered to students via game quests, which consisted of informer NPC, quest NPC, locales, learning tasks, narrative, and rewards. More specifically, learning materials in the *via-version* were integrated with the narratives of the quests delivered by an informer-NPC and quest-NPCs. In addition, the narratives were developed as the theme of mathematician's problems. Some famous mathematicians, such as Newton, Euler, Gauss, and Archimedes, are calling for help about math problems. Consequently, students in the *via-version* would meet the informer-NPC with the message that some famous mathematicians' math problems. Then students could explore different locales to obtain further information from certain quest-NPCs according to the cues provided by the informer-NPC. When they successfully completed learning materials, they would be rewarded by coins for their pets.

With regard to the *without-version*, the same learning materials were delivered by clicking a system menu, without informer-NPC, quest-NPC, and narrative, and locales. When they successfully completed learning materials, they were also rewarded by coins for their pets.

Goal-pursuing questionnaire

A goal-pursuing questionnaire developed by the first author was used to measure students' perception. This is because the design of quests involves students' motivation and goal-pursuing, there is no existing questionnaire available to completely reflect this aspects. Thus, we decide to develop a 5-scaled Likert questionnaire, which consisted of statements in three categories, including enjoyment, goal orientation, and goal intensity.

With regard to enjoyment, eight items were included. The sample items are “*I forget about time passing while playing the game*”, “*I feel emotionally involved in the game*”, and “*I have a strong sense of achievement when completing the tasks*”. They were modified from a motivational gaming scale (Dempsey, Lucassen, Haynes, & Casey, 1997) and a scale to measure students' enjoyment of e-learning games (Fu, Su, & Yu, 2009). With regard to goal orientation and goal intensity, six and four items were contained, respectively. The two categories of items were designed according to the interpretation of goal setting by Rand (1967), involving the degrees of specificity and difficulty as well as motivational aspects, such as direction, effort, and persistence (Lock, Shaw, Saari, & Latham, 1981). The sample items are “*goals were presented clearly in the beginning*”, “*I could establish specific goals*”, and “*I am stimulated to pursue certain goals*”.

To increase the validity of the questionnaire, these statements were further modified by a pre-service elementary school teacher, but the reliability of the questionnaire should be clarify in the future. The purpose of the questionnaire was to understand these participants' perception of their system use. Although the validity and reliability of the questionnaire have much room to be improved, the questionnaire could offer preliminary and immediate feedbacks.

Procedures

Since this experiment is a within-subjects design, all students were organized to experience the two system versions. To reduce the bias of treatment order, the within-subject groups were presented the two versions in a different order, as shown in Figure 6. More specifically, in Class A, participants first used the without-version for two sessions and then used the via-version for two sessions. In contrast, in Class B, participants first used the via-version for two sessions and then used the without-version for two sessions. Each session lasted 40 minutes and was held once a week. The procedures employed were as follows: (1) Before the experiment, participants were instructed to use the systems to ensure they know how to use. (2) during the these sessions, the number of participants' attempted tasks were also recorded in the system logs as a supporting evidence for goal-pursuing questionnaire. This is because the number of attempted tasks could be regarded as an indicator of students' goal-pursuing behavior. (3) At the end of each system version, the goal-pursuing questionnaire was administrated to collect students' perceptions.



Figure 6. Experimental setting: Two within-subject groups

Results

Students' perception of goal-pursuing

The questionnaire was administered to students subsequent to their participation in the experiment. The results of the questionnaire are presented in Table 2. The means of the via-version in three categories (e.g., enjoyment, goal orientation, and goal intensity) were higher than that of the without-version. To further validate the differences, the differences between the two system versions were found to be statistically significant by means of the t-test ($t=2.39$, $p<.05$; $t=2.28$, $p<.05$; $t=2.21$, $p<.05$ in the categories of enjoyment, goal orientation, goal intensity, respectively).

These differences indicated that participations in mathematics learning tasks using the via-version resulted in increased enjoyment, clearer goals, and stronger goal intensities.

Table 2. Summary table of t-test for questionnaire

	Via-version		Without-version		t
	Mean	S.D.	Mean	S.D.	
Enjoyment	3.56	1.023	3.07	1.159	t=2.39*
Goal orientation	3.56	0.955	3.10	1.178	t=2.28*
Goal intensity	3.41	1.008	2.95	1.171	t=2.21*

* <.05

To have a comprehensive understanding of the two within-groups, the experiences of the participants in each group were also analyzed in terms of three aspects of the learning tasks. As illustrated in Table 3, measures of the three categories were significantly higher for Class A, which experienced the via-version prior to the without-version (t=2.35, p<.05; t=2.27, p<.05; t=2.32, p<.05 in enjoyment, goal orientation, and goal intensity, respectively). These results revealed that participants who engaged in learning tasks had better experiences in the via-version in terms of the three aspects. Moreover, as shown in Table 4, measures of the three categories were lower for Class B, which experienced the without-version prior to the via-version. When the differences were further examined by t-test, two categories were found to be significantly different (t=3.23, p<.05 in enjoyment; t=3.08, p<.05 for goal orientation), while no statistically significant difference was observed for the category of goal intensity (t=1.91, p>.05). This implied that participants who used the without-version later had relatively negative perceptions in terms of two aspects.

The results of Class A and B were combined, controlling for order effects and background influences. These results indicated that game quests have a positive impact on the perceptions of participants, especially in the aspects of enjoyment, goal orientation, and goal intensity. In other words, students reported more joyful learning experiences in the via-version, learned more information in completing the quest, and had stronger intentions to accomplish quests. A possible explanation for this is that quests promoted interaction with NPCs and involved more expectations and satisfactions, which, in turn, affected students' perception of quests towards goal-pursuing.

Table 3. Summary table of t-test for Class A

	Pre-test (without version)		Post-test(via-version)		t
	Mean	S.D.	Mean	S.D.	
Enjoyment	3.51	0.74	3.94	0.74	t=2.35*
Goal orientation	3.54	0.94	3.89	0.65	t=2.27*
Goal intensity	3.28	1.00	3.76	0.65	t=2.32*

* <.05

Table 4. Summary table of t-test for Class B

	Pre-test (via-version)		Post-test (without-version)		t
	Mean	S.D.	Mean	S.D.	
Enjoyment	3.34	1.26	2.79	1.43	t=3.23*
Goal orientation	3.39	1.21	2.89	1.37	t=3.08*
Goal intensity	3.15	1.29	2.67	1.34	t=1.91

* <.05

Students' attempted behavior

Table 5 illustrates attempted tasks with and without quests. The total number of attempted tasks in the via-version (=750) was significantly higher than that in the without-version (=572), t=4.13, p<.01. On average, each participant in the via-version attempted 17.04 (=750/44) quests; whereas each participant in the without-version attempted 13 (=572/44) quests. These results indicated that students were more motivated to acquire quests in the via-version. These results seemed to be consistent with feedbacks given by participants on the questionnaire.

Table 5. Summary table of t-test for attempted tasks

	Via-version		Without-version		t
	Total	Mean	Total	Mean	
Attempted tasks	750	17.04	572	13.00	t=4.13*

* <.05

Discussion

Quests' influence on students' perception of task conduction

The results showed that quests had positive impact on elementary school students, a claim that was supported by two types of evidence. As described above, task assignment was controlled such that tasks were either assigned directly or were assigned in the context of quests. The responses given by students to the questionnaires indicated that game quests are perceived more positively when they were introduced in the context of quests.

Furthermore, as more tasks were attempted in conditions with quests, this indicated that when students are more willing to undertake tasks in the context of quests. Although from a technical perspective, the delivery of learning tasks is ultimately the same either with or without quests, the perceptions and willingness of students to participate in learning activities are quite different. The findings seemed to indicate that quests produced more active participation and promoted more enjoyable experiences. Therefore, these results suggested that a student-centered perspective should be taken by designers of learning systems. Accordingly, the inclusion of quests would result in increased motivation to accomplish the tasks due to students' perception of quest goals.

Moreover, game quests further involve another significant and interesting issue about the transfer between game goal and learning goal. More specifically, when learning tasks are embedded into the game quests, the learning goal seems to become a subordinate part in the pursuance of the game goal. Taking the two system versions as an example, in the without-version, students were assigned directly by the learning tasks. Their primary goal seems to complete the learning tasks; however, in the via-version, students received learning tasks via game quests, and their primary goal might be shifted to complete the game quests, in which the learning tasks become a side-effect for the primary goal. It is still unclear the influences of goal transfer on students' learning, and more research is required in the future.

Coupling mechanism: intrinsic or extrinsic approaches

Another issue that merits discussion is the coupling mechanism used in the three-tier framework. In this study, we adopt quests as the coupling mechanism, which actually could be determined by internal or external approaches. An external approach means that quests are designed in accordance with a domain-independent approach and are more strongly correlated with extrinsic motivation. Intrinsic approaches, on the other hand, closely bind the quests with the specific lesson that is being learned, which may be considered as intrinsic motivation.

Regarding the nature of intrinsic and extrinsic approaches, however, Deci and Ryan (1985) indicated that educators "cannot always rely on intrinsic motivation to foster learning...because many of the tasks that educators want their students to perform are not inherently interesting or enjoyable." In other words, an extrinsic approach might be also beneficial to students' learning, since students who are extrinsically motivated to value and emphasize their tasks could become self-regulated and motivated towards actions. It is possible for students to cultivate their intrinsic motivation for subject matter, if they latter find that the learning process is an interesting and rewarding experience that is driven from extrinsic motivation to undertake the tasks at the initial stages.

In addition, a promising advantage that extrinsic approach could bring is the effect of the side-effect learning, students' primary goal is naturally shifted as a game goal in which learning happened with the progress of the goal pursuing. Due to the flexibility of the extrinsic approach, learning contents in other subjects (e.g., language learning, science learning, or social studies) have more opportunities to be further integrated. For example, the knowledge of science learning or social studies could be integrated as a quest, which provides students with background knowledge or related information about science learning in the way of story-telling. In addition, understanding the content of

quests further involves students' reading in language learning. It is feasible to integrate language learning pedagogies to promote students' reading comprehension during the process of quest-taking, since narrative is a powerful method of information delivery, both for human culture transmission and for digital game design (Buckingham & Burn, 2007; Dickey, 2006).

Conclusion

This study shared an experience in developing a My-Pet-My-Quest game environment according to a three-tier framework. To answer the research question—*what are the influences of game quests on students' math learning in terms of perception of enjoyment and goal-pursuing*, this study conducted an experiment focusing on the examination of the quest mechanism. Quests were found to exert significant influences on students' perceptions, including enjoyment, goal orientation, and goal intensity. In addition, the findings revealed that quests encouraged active participation and increased the intensity of attempted learning behaviors.

However, due to the limitations of this experiment, some further investigations are required. Firstly, although this study showed positive influence of game quests on students, it was merely a short-term study. The long-term effects of quests are still unclear. In addition, because the questionnaire used in the experiment was developed by authors, its reliability and validity should be further examined in the future work. Finally, considering the ages of participants, other instruments (e.g., direct observation, interview or questionnaire to teachers) might be more precise to examine the effects of game quests. Other instruments could be taken into account in the future.

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