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The influences of an interactive group-based videogame: Cognitive styles vs. prior ability

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ABSTRACT

This study aims to investigate how cognitive styles and the levels of prior abilities influence frustration tolerance and learning achievement in an interactive group-based videogame named "Multiple-Choice Practice Island." In the aspect of cognitive styles, differences between field dependent and field independent students were explored. The results show that field independent students make better learning achievement but field dependent students demonstrate higher frustration tolerance. Besides, the low-ability students significantly made more improvement than the high-ability students. The low-ability students also demonstrate higher frustration tolerance in this study. The findings can guide designers how to develop adaptive group-based videogames that match the needs of each individual.

1. Introduction

Videogames, which utilize rich multimedia and highly interactive features, have demonstrated potential on facilitating students' social interaction. From an educational perspective, social interaction has positive effects on student learning (Engestrom, 1991; Lave & Wenger, 1991; Vygotsky, 1978). Therefore, integrating social interaction into the design of videogames may be able to improve student learning (Chang, Yang, Yu, & Chan, 2003). Due to such an advantage, we make use of videogames to design a multi-user sharing device (MUSD), where multiple users can have face-to-face interaction with each other (Infante, Hidalgo, Nussbaum, Alarcon, & Gottlieb, 2009). Such a MUSD environment provides many advantages. For example, it can break up an isolation, attract students' attention and engagement, and enables the exchanges of thoughts and ideas (Chang, Chuang, & Ho, 2013). In spite of such advantages, the MUSD also has some disadvantages. More specifically, such a face-to-face interactive environment might make participants feel pressured. Thus, the MUSD may not be always good. In particular, different learners have different perceptions so the MUSD may not be suitable to all learners. Thus, there is a need to consider individual differences so that the design of the MUSD could match with the needs of each individual, which can, in turn, enhance students' learning achievement.

Among various individual differences, prior ability (Chen, Fan, & Macredie, 2006; Mitchell, Chen, & Macredie, 2005) and cognitive styles play important roles. Regarding prior ability, learners with different levels of ability have different levels of

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understandings of the subject content of learning materials (Bulu & Pedersen, 2012; Chen & Huang, 2013). In general, high-ability students are referred to as high motivation, self-perceptions, and self-efficacy while low-ability students are referred to the contrary (McCoach & Siegle, 2001). Such differences are also demonstrated in game-based learning environments. For example, Orvis, Horn, and Belanich (2008) examined the influences of prior abilities in a videogame and found that high-ability learners performed better than those with low-ability but the latter improved their personal performance level to a greater degree than the former. Tsai, Yu, and Hsiao (2012) explored the influences of multiple human factors on learning effectiveness in a game-based learning environment, including students' motivation, prior ability, and online game experience. The students were asked to play an educational game, i.e., Super Delivery, which delivered the knowledge of electricity saving. The results showed that students' prior abilities positively affected their ability of gaining new knowledge while previous gaming experience influenced their skills of completing the game's task.

On the other hand, cognitive style, which refers to a person's information processing habits, capturing an individual's preferred mode of perceiving, thinking, remembering and problem solving (Messick, 1976), has been considered as another individual differences that can be used to drive adaption in digital learning systems. It has been suggested that matching cognitive styles to the design of learning activities can lead to better learning achievement (Huang, Hwang, & Chen, 2014). Furthermore, several studies examined the impacts of cognitive styles on student learning and they found that learners with different cognitive styles demonstrate different learning preferences (e.g., Kaewprapan & Suksakulchai, 2008).

Within the area of cognitive styles, field dependence has emerged as one of the most widely studied dimensions with the broadest application to problems in education (Messick, 1976). Field-independent (FI) students and field-dependent (FD) students show different reactions to educational contexts. FI students tend to exhibit more individualistic behaviors. Since they are not in need of external referents to process information, they are more capable of developing their own internal referents and restructuring their knowledge. However, FD students are more likely to be influenced by an external world than FI students (Witkin, Moore, Goodenough, & Cox, 1977). It seems that such different characteristics also influence how they react to a digital game, which includes various multimedia elements, such as graphics, animation and music. Hong, Hwang, Tam, Lai, and Liu (2012) found that FI students can more focus on gaming and the learning activity than FD students in a game environment. Moreover, the digital game looks like a virtual learning environment. Kaewprapan and Suksakulchai (2008) found that FD students are more motivated toward the virtual learning environment than FI students. As suggested by Hwang, Sung, Hung, and Huang (2013), students with cognitive style-fit versions showed significantly better learning achievement than those with non-fit versions. As mentioned above, both prior abilities and cognitive styles have great effects on student learning. However, there is a lack of studies to examine such effects in a MUSD environment. Unlike most of games presented in the aforementioned studies, the MUSD environment is a face-to-face interactive group-based videogame.

Additionally, previous research mainly emphasized on learning achievement and ignored other issues, such as frustration tolerance. Frustration means that the actual performance is far worse than what it is originally expected (Clifford, 1990). In other words, frustration suggests some uncomfortable experience, which may be related to prior abilities and cognitive styles. Regarding prior abilities, a student may have uncomfortable experience while s/he is doing a task beyond her/his ability. Regarding cognitive styles, a student may have uncomfortable experience when s/he uses a learning tool that mismatches with the preferences of processing information. If a student can have a correct attitude toward such uncomfortable experience, s/he can have a positive reaction to handle such emotion (Fischer, 1980). Therefore, there is a need to examine how students cope with such uncomfortable experience. Coping such uncomfortable experience needs to have an ability to accept failure, and then transfer into the power of his/her ability, i.e., frustration tolerance. To increase students' frustration tolerance, there must be a tolerance for error-making in a learning environment (Clifford, 1990). However, such an error-making practice is hard to be established in a traditional physical learning environment. On the other hand, videogames, which have unique attributes, such as interaction, risk taking, challenge and consolidation, pleasantly frustrating, provide students with good opportunities to take risks and make errors (Gee, 2005).

To this end, this study aims to examine the effects of prior ability and cognitive styles on learners' frustration tolerance and learning achievement. The aforementioned aim is achieved by implementing a MUSD environment, where a tablet supported competitive learning activity was designed for students to play videogames together. Furthermore, we conduct an empirical study to examine the influences of cognitive styles and prior ability on the students' learning achievement and frustration tolerance. It is believed that exploring how cognitive styles and prior ability affect students' learning achievement and frustration tolerance can lead to design an adaptive learning environment that can provide much better learning experiences for the students.

2. Methodology

2.1. Participants

Sixty-one 3rd grade students from an elementary school in Taiwan took part in this study. Among them, 33 were males and 28 were females. The age group of the participants ranged from eight to nine years old. Furthermore, all of them were inexperience in the game activity as well as the content domain of the MUSD.