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Incorporating customization and personalization into game-based learning: A cognitive style perspective

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ABSTRACT

In recent years, customization and personalization were widely applied to accommodate the needs of different cognitive style groups. Such two approaches have different advantages and disadvantages but there is a lack of studies to compare these two approaches from the perspective of game-based learning, which is currently popular in educational settings. To this end, we developed a customized game-based learning system and a personalized game-based learning system and conducted two empirical studies to examine how cognitive styles affected learner's reactions to these two game-based learning systems. The results from the customized game-based learning system showed that Holists might not always favor to listen to music because they frequently switched on/off music. On the other hand, Serialists did not prefer to use hints. In addition, learners with the customized game-based learning system had more positive perceptions while learners with the personalized game-based learning system had more negative perceptions though both systems were useful to enhance learners' learning performance, regardless of their cognitive styles.

1. Introduction

Digital games have made great contributions to student learning (Braghirolli, Ribeiro, Weise, & Pizzolato, 2016). This may be because digital games can motivate learners, arouse their curiosity, and allow learners to control their learning paths (Dickey, 2007; Papastergiou, 2009). Because of such benefits, researchers attempted to incorporate digital games into different courses so that playing and learning are integrated together (Dorji, Panjaburee, & Srisawasdi, 2015). This might also be the reason why game-based learning (GBL) emerged.

It is found that GBL can make students enjoy studying for their courses (Kazimoglu, Kiernan, Bacon, & MacKinnon, 2012). This may be due to the fact that GBL includes various game elements, e.g., hints, music, and narratives. On the one hand, such game elements make GBL contain rich information. On the other hand, these game elements might force learners to process various types of information simultaneously (Kalyuga & Plass, 2009) so their cognitive load may be increased (Kiili, 2005). However, not all of learners have enough capacities to overcome such a problem because individual differences exist among learners. Therefore, there is a need to investigate how individual differences are associated with the use of these game elements.

Among various individual differences, cognitive styles particularly play an essential role because they affect a person's information processing habits, capturing an individual's preferred mode of perceiving, thinking, remembering, and problem solving (Messick, 1976). Thus, a number of studies examined the influences of cognitive styles on student learning (e.g., Chen & Liu, 2011). Among several dimensions of cognitive styles, existing research mostly emphasized on Witkin's Field-Dependence/Field-Independence (1977). Further to Field-Dependence/Field-Independence, Pask's Holism/Serialism (1976) is another influential dimension of cognitive styles. Either Witkin's Field-Dependence/Field-Independence or Pask's Holism/Serialism pertains to the wholistic-analytic family (Peterson & Deary, 2006). Similar to Field Dependent individuals, Holists perceive objects as a whole in that they tend to process information in a relatively global fashion. Conversely, Serialists prefer to take a pattern which is similar to that of Field Independent users, focusing on individual parts of the object, because they tend to maintain a local focus (Chen and Macredie, 2004). In brief, Holists and Serialists have different

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preferences.

Thus, there is a need to accommodate their different preferences. Two approaches can be applied to accommodate learners' preferences. One is personalization while the other is customization. The former uses a system-driven approach to make an automatic adaptation for users while the latter uses a learner-driven approach to enables users to adapt the content layout and navigation support to their preferences by themselves. (Treiblmaier, Madlberger, Knotzer, & Pollach, 2004). Several works attempted to integrate personalization and customization into technology-based learning (e.g., Frias-Martinez, Chen, & Liu, 2009). However, there is a lack of studies to use personalization and customization to develop GBL systems that accommodate the preferences of Holists and Serialists.

To fill this gap, we developed both customized and personalized GBL systems and conducted two empirical studies to compare learners' reactions to these two GBL systems from a cognitive style perspective. The relationship between these two studies is shown in Fig. 1. As shown in this figure, we developed a Customized GBL System (CGLS), which allowed learners to choose game elements based on their particular needs and examined how different Holists and Serialists reacted to the CGLS in Study 1. The results from Study 1 were applied to develop a Personalized GBL System (PGLS), which included two versions, i.e., Holist version and Serialist version. Subsequently, Study 2 was undertaken to compare reactions to the CGLS and PGLS from a cognitive style perspective. Accordingly, the ultimate aim of this research is not only to implement customized and personalized GBL, but also to provide a complete understanding of the effects of cognitive styles on students' reactions to customization and personalization in the context of GBL.

2. Literature review

2.1. Holists vs. Serialists

Like Witkin's Field-Dependence/Field-Independence, Pask (1976) Holism/Serialism is considered as an influential cognitive style in student learning (Huang, Hwang, & Chen, 2014). As shown in Table 1, Holists and Serialists have different information processing patterns. Holists prefer to process information in a 'whole-to-part' sequence while Serialists prefer a 'part-to-whole' processing manner (Jonassen & Grabowski, 1993). In other words, learners with a holistic style tend to take a global learning approach while those with a serialistic style prefer to use a local learning approach.

Due to such differences, recent studies attempted to put effort to investigate how Holists and Serialists reacted differently to technology-based learning. For instance, Clewley, Chen, and Liu (2011) found that Holists and Serialists used different ways to interact with a Web-based learning system. More specifically, Holists favored to use links to discover the relationships between topics while Serialists preferred to use an index to find a route for a specific task. Subsequently, Subsequently, Chen et al. (2013) examined how cognitive styles influenced learners' reactions to personalized and non-personalized learning systems that tailored to learners' prior knowledge. The results reported that Serialists had negative reactions to the non-personalized scenario while Holists seemed to perceive the usefulness of the personalized scenario positively. Furthermore, Chan, Hsieh, and Chen (2014) examined how Holists and Serialists used electronic journals. The results showed that Holists and Serialists used different ways to judge the relevance of documents. More specifically, Holists tend to use a variety of approaches while Serialists prefer to use a single approach. In brief, the results from previous research demonstrated that Holists and Serialists have different learning preferences. Nevertheless, few studies examined differences between Holists and Serialists in the context of GBL.

2.2. Game-based learning

Previous research indicated that GBL possessed many positive effects on students learning, in terms of learning motivation, learning performance and learning perceptions. Regarding learning motivation, Woo (2014) built a small factory game (OSF) to teach students to acquire computer-aided manufacturing (CAM) abilities. The results indicated that the game-based learning system (OSF-CAM) could stimulate students' learning motivation. Regarding learning performance, Kebritchi, Hirumi, and Bai (2010) conducted a study to investigate the effects of GBL on students' mathematics performance. The results indicated that students with GBL received greater gain on their mathematics achievement than those with traditional instruction. The other study conducted by Admiraal et al. (2014) examined the effects of GBL. The result showed that students with a GBL environment demonstrated better learning performance than those with a non-game environment. Regarding learning perceptions, Kazimoglu et al. (2012) used a GBL system to teach computing logics. Their finding indicated that the GBL system could not only make students enjoy studying for this course, but also they perceived that their programming abilities were enhanced.

Due to the aforementioned positive effects, researchers attempted to identify which game elements brought such effects. Among various game elements, narratives, hints and music may be the elements that contribute to the positive effects. Regarding narratives, Benton, Vasalou, Gooch, and Khaled (2014) found that game narratives might evoke learners' curiosity and foster learners' imagination. Moreover, narrative was found to be useful to make players immerse in the game world and enhanced their

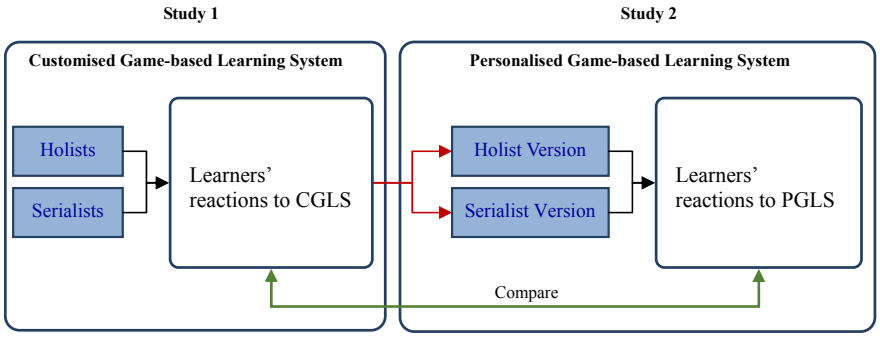

Fig. 1. The relationship between Study 1 and Study 2.