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The evaluation of different gaming modes and feedback types on game-based formative assessment in an online learning environment

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ABSTRACT

This study proposed an online learning system for energy education, modifying the typical rules of tic-tac-toe and incorporating multiple choice tests into the game in order to develop a game-based formative assessment tool for an online learning course. In order to explore how different gaming modes and feedback types in this game-based formative assessment affect knowledge acquisition effectiveness and participation perceptions, a tic-tac-toe quiz game (TRIS-Q) with two gaming modes: single-player online game (SOG) and multi-player online game (MOG), and two feedback types: immediate elaborated feedback (IEF) and no immediate elaborated feedback (no IEF), were developed. A 2(SOG vs. MOG) × 2(IEF vs. no IEF) between-subject experiment was also conducted to investigate the effects on 109 ninth-grade students from four junior high school classes. The research findings indicated that different gaming modes of TRIS-Q did not affect the effectiveness of knowledge acquisition; providing IEF for each question answered in the game facilitated the enhancement of both energy knowledge acquisition and student tic-tac-toe ability when comparing it with the no IEF type. Additionally, the different gaming modes and feedback types did not affect participation perceptions.

1. Introduction

Online courses are acknowledged in the current educational system because they generate numerous merits unavailable in traditional settings (Bell & Federman, 2013; Billings, 2007; Duffy, Lowyck, & Jonassen, 1991). However, many researchers have claimed that the primary problem of online courses is their higher dropout rates (Frankola, 2001; Jun, 2005; Meister, 2002); this is primarily because individualized learning environments can cause students to lose their learning motivation when interaction and timely guidance are lacking. Thus, in order to enhance both interaction and guidance, online synchronous and asynchronous communication tools, such as chat rooms, video conferencing and forums have become common functions in online learning systems (Billings & Rowles, 2001; Reid, Flam, & Tsiouris, 2012). In addition, to prevent online learners from losing learning motivation when reading online learning contents, multimedia materials, including audio, video, animation, or even game-based learning are advocated in designing online courses (Aldrich, 2009; Prensky, 2001).

Furthermore, online formative assessment functions are also required in current online learning systems for self-assessment and self-improvement when learners engage in individualized learning (McKimm, Jollie, & Cantillon, 2003; Vasilyeva, Pechenizkiy, & Paul De Bra, 2008). However, although online formative assessment offers opportunities to repeat tests or practice at convenient times, some studies also found that not all online learners use online formative assessment tools in their online learning (Buchanan, 2000; Henly, 2003). An increasing number of researchers (Costal, Mullan, Kothe, & Butow, 2010; Lin & Lai, 2013) have noted that enhancing the participation rate for using online formative assessment in online learning has become more critical.

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In order to address the above problem, some scholars have proposed employing game-based formative assessments in online learning. For example, Wang (2008) verified that game-based formative assessment can enhance motivation to use online assessments and improve learning effectiveness. However, since traditional online assessments are used individually, current game-based formative assessments in online learning, such as in Wang's research, typically adopt a single-player online game (SOG) strategy. As a result, research related to multi-player online game (MOG) strategies in online formative assessments is sparse, despite the fact that massively multi-player online games (MMOGs) have increasingly become the dominant form of computer games for adolescents.

Therefore, this study attempted to develop an online formative assessment game with MOG strategy for exploring its effectiveness used in an online learning course for energy education. The following section will first discuss how this study adopted the MOG strategy and formative feedbacks suitable for designing this formative assessment game. Subsequently, the research questions and hypotheses of the study will be described.

1.1. MOG strategy suitable for designing formative assessment game

Many people, when playing a game, experience a degree of pleasure, typically becoming so focused that they enter what Csikszentmihalyi (1990) called the state of flow. Thus, gaming is recognized as an activity that can stimulate intrinsic motivation (Garris, Ahlers, & Diskell, 2002; Malone, 1981). Because various educational programs are required to stimulate the intrinsic motivation of learners, games are often applied in education (Randel, Morris, Wetzel, & Whitehall, 1992). With the rapid development of technology, computer games have increasingly replaced traditional games in young people's daily lives, and the online courses are being used in a wide variety of different environments, such as schools and enterprises. Based on the trend for the research toward many positive effects of playing digital games (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Gee, 2003) and the requirement of promoting motivation for online learners, computer games are also applied in online education. Nowadays the well-known terms such as digital game-based learning (DGBL) or serious game have been established for referring to the digital games on educational purposes, and used widely in online learning.

Numerous studies have indicated that DGBL enhances student learning motivation and effectiveness (Clark, Nelson, Sengupta, & D'Angelo, 2009; Vogel et al., 2006; Yang, Chien, & Liu, 2012). As technology and the Internet have developed, multiple studies on DGBL (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005; Tsai, Yu, & Hsiao, 2012) have used the MOG strategy. However, Tsai et al. concluded that multi-player DGBL was likely to generate over-competitiveness, causing players to overlook learning content, particularly in real-time-based MOG. Whereas the MOGs using real-time strategy involve time limits, others are turn-based MOGs, such as board and card games. Board games require turn-taking, and when one person is playing, other participants must wait. For example, tic-tac-toe is a classic turn-based multi-player game developed in Egypt (Zaslavsky, 1982); two players take turns placing the pieces on a 3×3 table. The first person who makes a row, column, or diagonal line of three pieces is the winner.

Because the rules and the game itself are simple, tic-tac-toe is a commonly played game, and is appropriate for everyone (Crowley & Siegler, 1993). A tic-tac-toe-based game therefore seems to be suitable for use in designing a formative assessment game rather than a real-time-based game, since it requires no player urgency, allowing participants sufficient time to think. Meanwhile, the simple game rules are appropriate for students, and it can be developed as SOG or MOG. For example, Hung's (2011) study combined computerized tic-tac-toe with formative assessment as a single-player formative assessment game. Moreover, many studies have indicated that playing chess is an educational activity because it can increase concentration and enhance problem-solving, memory and mathematics competency (Gobet & Campitelli, 2006). Some researchers (Bönsch, 1987; Kotov, 1971) also indicated that repeatedly playing chess enhances chess-playing ability. Hence, tic-tac-toe was adopted as the game strategy for designing the game-based formative assessments in this study.

1.2. Formative feedback types suitable for designing formative assessment game

Learning assessment can typically be divided into summative and formative assessments. Summative assessment is conducted after the whole learning activity is completed to assess total learning effectiveness regarding specific course materials, and whether the student performed successfully overall (Bloom, Hastings, & Madaus, 1971). Formative assessment was first proposed by Scriven (1967) and later defined by Bloom, Hasting and Madaus, whose definition has been widely used. It is mainly used during the learning process to provide learning feedback and enhance learning performance (Sadler, 1998). Thus, formative assessment is crucial to individualized online learning because the immediate feedback provided by online formative and computer-assisted assessment enables students to immediately self-assess and self-improve. Many studies have also supported that learning motivation and performance are improved in an online learning environment with the engagement of online formative assessment (Gardner, Sheridan, & White, 2002; Henly, 2003; Khan, Davies, & Gupta, 2001).

Feedback in educational situations has always been viewed as a critical factor for improving knowledge and acquiring skills (Shute, 2008). The primary value of online formative assessment is that the mechanism of computer-assisted assessment can provide immediate feedback messages tailored to the learner's assessment results (Dalziel, 2001). Based on the level of information presented in feedback messages, the common formative feedback types can be divided into knowledge of results (KR), knowledge of correct response (KCR) and elaborated feedback (EF) (Dempsey, Driscoll, & Swindell, 1993; Shute, 2008). KR feedback informs students whether their answer is correct or incorrect, but does not offer the correct answer. KCR feedback offers the correct answer, whereas EF may or may not reveal the correct answer, and provides a detailed message that comprises information or clues relevant to the question, guiding learners toward the correct answers. Furthermore, based on feedback timing, feedback can be divided into immediate feedback (IF), which provides instant feedback to learners after completing the assessment or a question, and delayed feedback (DF), which provides feedback messages after a few minutes or longer (Shute, 2008).

Findings regarding IF and DF vary as each has advantages. Certain scholars have proposed that because IF prevents incorrect answers from entering the memory, using IF should lead to superior learning effectiveness compared with DF (Corbett & Anderson, 1989; Dihoff, Brosvic, Epstein, & Cook, 2003). Other scholars have also asserted that IF should be a required strategy for online formative assessment in online learning (Buchanan, 2000; Henly, 2003); however, others have contended that DF enhances learner memory, allowing them to easily memorize correct answers (Kulhavy & Anderson, 1972; Surber & Anderson, 1975). Most studies have indicated that compared with