The Journal of Academic Librarianship xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

The Journal of Academic Librarianship

journal homepage: www.elsevier.com/locate/jacalib

Does Physical Activity Enhance Learning Performance?: Learning Effectiveness of Game-based Experiential Learning for University Library Instruction☆

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ARTICLE INFO

Keywords:
Experiential learning
Game-based learning
Mobile learning
University library instruction

ABSTRACT

This paper reports research results of the proposed experiential learning using a game-based educational material. The educational material was an application running on a mobile device and was supported for learners to study university library instruction. During the experiential learning, the learners answered several quizzes provided from the educational material. The quizzes were including experiential contents such as actually to find an academic journal or to reserve a learning room. In order to evaluate learning effectiveness of the experiential learning, this research made a comparative experiment. The experimental group used the educational material and the control group used another educational material of e-learning (non-experiential) but the contents was almost same as the contents of the experiential learning. The comparative experiment took several evaluation elements such as pre-/post-test scores, delayed-test scores and learning motivation scores based on IMMS of ARCS model. The experimental results revealed that experiential learning was superior for the several elements of these metrics. This research, furthermore, analyzed learner's operation data to the educational material and learner's behavior data during the learning in the experimental group. The analyzing results showed three types of the learning behaviors and indicated that an instructor needs to adopt suitable instructional design to each type to bring superior learning effectiveness.

Introduction

Recently, attention around the world has been paid to game-based learning environments as effective learning environments. The effects of game-based learning environments on learning have been investigated by many researchers in such respects as the enhancement of learners' learning motivation (Jong, Lai, Hsia, Lin, & Lu, 2013) and improvement of learning engagement (Connolly, Stansfield, & Hainey, 2011). However, game-based learning design should be considered in order to confirm the possible effects of game-based learning (Clark, Tanner-Smith, & Killingsworth, 2016; Tang et al., 2017). One useful referential design framework is instructional design, which is used to build an educational model including several processes of planning, practicing, and evaluation for building an effective learning situation. The ADDIE model (Analysis, Design, Development, Implementation and Evaluation) is a famous model to practice these processes. Instructional design is one of the important factors in educational settings. Alaswad and Nadolny (2015) suggested that game-design processes integrate game design and instructional design. They also proposed an integrated design process based on ICT use from the viewpoint of the relationships between game factors and learning goals, and between game features and evaluation points.

The target education field in this research is university library instruction, which we selected because the instruction needs experience to master the details, e.g., a procedure how to look for the book or journal one wants or to reserve a group study room. Therefore, the

☆ This paper aims to investigate the effects of a game-based educational material using smartphone on experiential learning. In order to evaluate learning effectiveness of the experiential learning, this research had a comparative experiment. The experimental group used the educational material and the control group used another educational material of e-learning. The experimental results revealed that experiential learning was superior for the several elements. We analyzed learner's operation data focusing on experimental group. The results showed three types of the learning behaviors and indicated that an instructor needs to adopt suitable instructional design to each type to bring superior learning effectiveness.

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https://doi.org/10.1016/j.acalib.2018.06.002
Received 13 December 2017; Received in revised form 14 May 2018; Accepted 14 June 2018

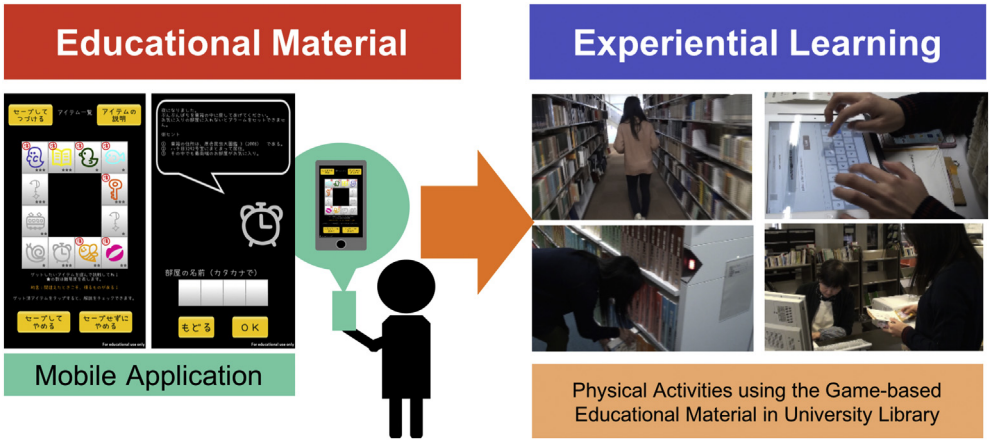

Fig. 1. Overview of the proposed educational material and experiential learning.

instruction is suitable for examining the learning effectiveness of game-based experiential learning. Fig. 1 shows the overview of the proposed educational material and the experiential learning. The educational material was an application running on a mobile device and was supported for learners to study university library instruction. During the experiential learning, the learners answered several quizzes provided by the educational material. The quizzes were including experiential contents such as actually to find an academic journal or to reserve a learning room. Learners need to do physical activities to learn the contents. For the purpose of a comparative examination, this study had two types of groups, one an experiential learning group that used the proposed game-based educational material and the other a non-experiential learning group that used e-learning-based educational materials. In this research, learning effectiveness was measured from the viewpoints of subjective evaluation data and objective evaluation data. Subjective evaluation data include two types of scores: test scores examining the degree of understanding and questionnaire scores examining learning motivation. Objective evaluation data means log data of how a learner operated the game-based educational material. Investigating the log data of a learner who obtained a high score on these tests can give information to teachers and researchers that is helpful for designing a superior instructional model. These Data-Driven Design approaches will become more important in education in the future. This paper explains what kind of learning effectiveness arises from the game-based experiential learning by comparing the subjective/objective evaluation data of the two groups, and also discusses superior instructional design based on the comparative results.

Research purposes

The purposes of this research are to clarify the following three research questions (RQ). RQ1: “Does a game-based learning method with physical activity yield higher learning performance for acquiring declarative knowledge about library instruction than a common e-learning method?”; RQ2: “Is a learner who experiences a game-based learning method with physical activity more effectively able to bring out the acquired knowledge to actual physical tasks than the one who experiences a common e-learning method?”; RQ3: “What kind of process does a learner who experienced a game-based learning method with physical activity undergo during the learning?”

Literature review

Game-based learning contains two types of instruction style; one is instruction using Serious Games (Susi, Johannesson, & Backlund, 2007) and the other is instruction adopting a method called Gamification (Huotari & Hamari, 2012). These two styles are similar in that they both use “games” for instruction; however, the concepts of the two are completely different. Serious Games have the concept that a learner plays a game and learns about a certain subject through playing it. On the other hand, Gamification has the concept that a learner studies a certain subject in a learning environment that adopts game-like elements such as competition or collaboration. Both styles have the common concept of “learning something with enjoyment.” The proposed educational material in this research is a learning system adopting Gamification rather than Serious Game.

These days, mobile technologies have promoted the spread of the physical moving approach using location data, and thus have helped to shape new educational activities (Melero, Hernández-Leo, Sun, Santos, & Blat, 2015). Location-based games with physical movement can offer authentic inquiries in which learners can become immersed (Squire & Jan, 2007; Tang et al., 2017). Information technologies such as mobile phones bring in new features of serious games and promote effective learning behaviors with physical movement. When a teacher tries to practice such experiential learning, the processes of designing an instructional model become important. Appropriately designed, the processes of planning, practice, and evaluation give more effective results in educational settings.

Plass, Homer, and Kinzer (2015) organized four elements of game-based learning from the viewpoint of perceived effects of game-based learning: affective (e.g., presentation), motivation (e.g., self-efficacy), cognition (e.g., scaffolding, motion), and social/cultural elements (e.g., relevance, participative learning culture). Jabbar and Felicia (2015) suggested that supporting learning engagement in terms of emotion and cognition promotes knowledge acquisition, practicing and processing, knowledge application and reflection, and knowledge anticipation. Ke, Xie, and Xie (2016) indicated that the learning engagement in game-based learning is a continuous learning process from emotional engagement to game-action engagement, and cognitive learning plays important roles in the enhancement of learning. Psychological and cognitive learning viewpoints were essential design elements for game-based learning; however, it is not adequate to discuss the element of physical activity in game-based learning as game-based learning design. It seems desirable to collect the research findings on game-based learning, including physical activity, for this research field. One study indicated the health effects of the physical-movement game “Pokemon Go” compared to a control group (Althoff, White, & Horvitz, 2016), but the effects on learning were not discussed. This study aims to develop the physical moving game-based learning environment in a library education setting and evaluate its effects, based on the instructional design.

In the research field of game-based library education in a university environment, Hori et al. (2014) developed and evaluated a document retrieval game. Leach and Sugarman (2005) introduced a jeopardy-