International Journal of Child-Computer Interaction 2 (2014) 101–108

Contents lists available at ScienceDirect

International Journal of Child-Computer Interaction

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

Student behavioral engagement during mathematics educational video game instruction with 11–14 year olds

Kirby Deater-Deckard [a,*], Shereen El Mallah [a], Mido Chang [b,1], Michael A. Evans [c,2], Anderson Norton [d,3]

[a] Department of Psychology, Virginia Tech, 109 Williams Hall (0436), Blacksburg, VA 24061, United States
[b] Department of Leadership and Professional Studies, Florida International University, ZEB 250B, Miami, FL 33199, United States
[c] Department of Learning Sciences and Technology, Virginia Tech, 306 War Memorial, Blacksburg, VA 24061, United States
[d] Department of Mathematics, Virginia Tech, 460 McBryde, Blacksburg, VA 24061, United States

ARTICLE INFO

Article history:
Received 16 April 2014
Received in revised form
8 July 2014
Accepted 14 August 2014

Keywords:
Education
Computer assisted instruction
Adolescents
Tablet computers
Field studies

ABSTRACT

"Serious digital games" for education are presumed to be engaging, but little is known about whether engagement is ubiquitous, whether it persists over time, whether it is found for all students across the full range of prior gaming experience, and whether it is actually associated with game-based learning outcomes. To address these gaps, student behavioral engagement (i.e., sustained attention, persistence was examined during mathematics instruction using a mathematics serious digital game for the iPad®, in a study of 97 11–14 year olds (i.e., 6–8th grade students in the United States system). Consistent with the study hypotheses, observations revealed that most students were highly engaged, but engagement was lower for students who were observed later in the semester and who had the most prior gaming experience. In addition, observed engagement was associated with better performance on an assessment of the skills being taught in the game. In contrast, none of these effects was evident for self-reported student engagement. Time course, prior gaming experience, and method of assessing engagement are important modulators of student differential response to game-based instruction and should be considered when evaluating the influence of serious digital games on learning outcomes.
© 2014 Elsevier B.V. All rights reserved.

1. Introduction

The proliferation of mobile computing devices such as tablets and smartphones, with accompanying growth in "serious digital games" (SDGs) for education in formal and informal learning settings, have the potential to revolutionize curriculum and instruction. In theory, one of the more exciting aspects of SDGs is that they provide challenging learning opportunities that are nevertheless fun and engaging to a wide variety of students. However, this has not been widely tested; to our knowledge, there have been few empirical investigations of student engagement with mobile device SDGs using observations and student self-reports. Therefore, the goal in the current paper was to answer several questions regarding 11–14 year old student engagement (i.e., "middle school", spanning 6th, 7th and 8th grades in the United States education system) with a mathematics SDG on the Apple iPad®, based on observations and self-reports of a diverse sample of students. The four guiding questions in the research were as follows: (1) Do "middle school" students show signs of engagement with mathematics educational video games when they are used as part of classroom instruction? (2) Does engagement persist over time? (3) What is the role of prior video gaming experience on engagement with the math SDG? (4) Is greater engagement during game play associated with better performance on a math test based on the pedagogy and content of the game?

1.1. SDGs, engagement, and learning

Educational SDGs have been identified as potentially beneficial learning environments [1,2]. They leverage game mechanics (and other features of multimedia) to engage the learner, while allowing for incremental introduction of target content that accommodates

* Corresponding author. Tel.: +1 540 231 0973.
E-mail addresses: kirbydd@vt.edu (K. Deater-Deckard), midchang@fiu.edu (M. Chang), mae@vt.edu (M.A. Evans), norton3@vt.edu (A. Norton).
1 Tel.: +1 305 348 6857.
2 Tel.: +1 540 231 3743.
3 Tel.: +1 540 231 6942.

http://dx.doi.org/10.1016/j.ijcci.2014.08.001
2212-8689/© 2014 Elsevier B.V. All rights reserved.

learner knowledge and skills, and providing contextualized well-timed feedback to ensure attention and retention of new knowledge.

By taking advantage of particular game mechanics [3], that is, the explicit rules implemented by designers that determine how an agent (player) interacts with the procedural game system, SDGs are inherently structured to accommodate many levels of proficiency through gameplay, appealing to students of diverse demographic backgrounds and varied learning styles. The games often provide a series of short-term feedback loops, assessing knowledge in manageable doses that is more conducive to acquiring new skills [4,5].

Moreover, as students challenge themselves to advance through game levels, well designed SDGs promote goal-setting, provide instant feedback, track overall progress and assess competency of target skills. By virtue of their progress through the game, students are able to demonstrate their mastery of steps. Furthermore, the experience of failure within a game context may lessen overall discouragement and frustration brought on by typical modes of instruction and assessment [6,5]. This last point deserves particular emphasis, because SDGs are programmable media that allow the designer – through playtesting and usability testing – to calibrate mechanics and user feedback to ensure that the player's attention is focused toward targeted content. In addition, the same game mechanics can be utilized to enhance "re-playability", which could better ensure retention of new knowledge as the player voluntarily chooses to try the game again to succeed [7].

The potential for SDGs has been advocated and increasingly is being documented [8,1,9,2]. Furthermore, calls for adopting SDGs and associated game mechanics to a broad spectrum of educational and training settings is on the upswing [10]. However, the literature on the role of SDGs on student engagement with games and their content currently is lacking. Therefore, the goal in the current study was to produce replicable empirical research on the potential influences of SDGs on engagement and learning—to present data with direct implications for instruction, assessment, and design of future technology-enhanced learning (TEL) platforms. In particular, there is a growing consensus that attention must be paid to leveraging the affordances of TEL in areas such as educational data mining and learning analytics (USDOE, [11]). Results reported in the current study provide initial evidence for the types of data on engagement and achievement that could be used, to enhance instruction and learning in increasingly digital educational worlds.

In our work, we focus on mathematics in middle school, when young adolescents are making the transition from a part–whole schema to a splitting/iteration schema for understanding and manipulating fractions—a crucial step toward algebraic reasoning [12,13]. Failure to acquire basic proficiency with fractions by the end of middle school is one of the major predictors of high school and post-secondary educational failure [14]. Thus, there is a need to develop and test new SDGs designed for middle school mathematics.

In the current study, we examined student use of CandyFactory, a fractions schemes game designed for the Apple iPad that involves selecting and manipulating objects of various sizes to try to match targets within a set time period, in order to earn points and receive rewards like badges and trophies. Teachers used the game twice a week during 20-min game play sessions during their regularly schedule math class periods which lasted for 45–60 min. Teachers determined when the sessions occurred within that time frame on any given day. The game was designed so that students cannot simply rely on part–whole conceptions of fractions; in order to succeed, they must split and iterate objects to match the targets [15]. The pedagogical foundation for the game was based on a hierarchy of five schemes, in order of complexity and proficiency: the *partitive unit fraction scheme*, the more general *partitive fraction scheme*, the *splitting scheme*, the *reversible partitive fraction scheme*, and the *iterative fraction scheme*. These five schemes describe a hierarchy for how students operate with and conceive fractions [16]. The purpose of the current study was not to assess whether the game "worked" in terms of building mathematics knowledge, but whether it was engaging—a crucial feature of any potentially effective SDG.

1.2. Behavioral engagement and SDGs

Student engagement is defined in a wide variety of ways in the psychological, educational, and computer sciences [17–19]. In the current study, we focused on several major aspects of cognitive, behavioral and affective engagement including sustained attention, motor persistence, and apparent interest [20,21]. These attributes are manifested in *behavior* that can be assessed objectively through observation during game play as well as subjectively through students' self-perceptions [22]. This is distinct from broader definitions that also include social cognitive components (e.g., self-perceived feelings, beliefs, and attitudes) that together with behaviors comprise "motivation" to engage with the game and material.

To our knowledge, there is not an empirical literature on student engagement among middle school students playing mathematics SDGs. More broadly, research on the effects of SDGs on student engagement across a variety of ages and content domains has yet to reach a consensus, thus providing opportunities for evidence-based contributions to extant literature.

Take for example a study conducted by Annetta et al. [23] where researchers highlight a positive effect of an SDG on student engagement in the science classroom. For the reported effort, researchers developed an SDG that was designed to invite students to solve a murder case. In the game, students were tasked to use knowledge of genetics to identify a criminal with the highest probability. As part of designed game play, students created avatars for themselves, interacted with other avatars, and traveled in the virtual environment to solve the mystery. The researchers compared the engagement levels of students who played the game with those who learned the same materials through paper and pencil drills. Students who played the game displayed higher levels of engagement in genetics learning. Important to note is that student engagement levels were all reported high in behavioral, emotional and cognitive components.

In contrast, a study conducted by Lim et al. [24] did not support the hypothesis that treatment groups playing SDGs would report higher levels of engagement. The goal of these researchers was to support students to learn critical aspects of the water cycle in a science class through an educational game (Quest Atlantis), which is a multi-player 3D chat environment framed by missions and challenges as primary game mechanics. Similar to the educational game by Annetta et al. [23], students who played Quest Atlantis chose avatars for their virtual identity, worked with other avatars, and completed quests to solve an environmental problem in Atlantis. When the researchers measured the effectiveness of the game using seven indicators of engagement, those who played Quest Atlantis showed low levels of engagement overall.

Use of SDGs in classrooms to produce demonstrable changes in learning outcomes also has yielded mixed results. For example, Din and Calao [25] conducted an experiment by implementing a Sony PlayStation educational video game into a preschool classroom. Post-test results showed effects for spelling and phonological decoding but not for math skills. Rosas et al. [26] conducted a similar experiment in Chile, but with a much larger sample (nearly 1300) of older (1st and 2nd grade) students. SDGs were employed during classes in order to determine their effects on basic language and mathematical competencies. Additionally, teacher effectiveness,

دریافت فوری ← متن کامل مقاله

ISIArticles
مرجع مقالات تخصصی ایران

✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
✓ امکان دانلود نسخه ترجمه شده مقالات
✓ پذیرش سفارش ترجمه تخصصی
✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
✓ دانلود فوری مقاله پس از پرداخت آنلاین
✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات