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User Engagement in Educational Computer Gaming

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ABSTRACT
This research-in-progress paper uses the grounded theory approach to understand user engagement in educational computer gaming. Twenty-one subjects who have experienced engagement with educational computer games were interviewed about their engaging experience with educational computer games. The preliminary results are presented in this paper, where they are conceptualized into three main categories: (i) conditions of engagement, (ii) characteristics of engagement, and (iii) outcomes of engagement.

Keywords
Engagement, educational computer games, grounded theory.

INTRODUCTION
Computer games are increasing in popularity and they show great potential to become an effective means of delivering education. Computer games that deliver educational content and value to users can be broadly termed educational computer games (ECGs). ECGs have the advantage of combining education and entertainment, thus giving rise to a new term, edutainment (Green and McNeese, 2007). For ECGs to be effective, they need to engage the users (Egenfeldt-Nielsen, 2007). It is, therefore, important for game designers and developers to maximize the efficacy of ECGs by engaging users in their educational gaming experience. Hence, we conducted an empirical study that uses the grounded theory approach to identify the following components of user engagement with ECGs: (i) antecedents and conditions of user engagement, (ii) characteristics of user engagement, and (iii) outcomes of user engagement.

REVIEW OF RELATED LITERATURE
Theory of Active Engagement, also called Engagement Theory, has been proposed by Kearsley and Shneiderman (1998). The fundamental idea underlying this theory is that learners must be “meaningfully engaged” in their learning tasks and activities which can be achieved by making learning more collaborative, project-based, and authentic through the use of technology. Studies have shown that active engagement is related to motivation and active learning (Cavanagh, 2011; Scoresby and Shelton, 2011; Skinner and Chi, 2012).

Malone (1981) identified challenge, curiosity, and fantasy as three key components of intrinsically motivating instruction. He indicates that these three components contribute to user engagement in learning. Challenge refers to the existence of goals with uncertain outcomes. Curiosity occurs when certain stimuli arouse one’s interest or attention. Fantasy refers to mental images of things that help to sustain interest.

Garris, Ahlers, and Driskell (2002) developed an input-process-outcome game model that comprises instructional content and game characteristics as the inputs feeding into a game cycle (process) comprising system feedback, user judgments, and user behavior to produce learning outcomes. They suggest using game features to trigger a game cycle that characterizes user engagement, and define game characteristics in terms of six broad dimensions: fantasy (or imaginary things), (clarity of) rules/goals/feedback, sensory (visual/auditory) stimuli, challenge (i.e., optimal level of difficulty and uncertain goal attainment), mystery (i.e., optimal level of informational complexity), and (active learner) control.

O’Brien and Toms (2008) studied user engagement in four areas of application: educational applications, video games, online shopping, and Web searching. Four stages of engagement were identified in their study: point of engagement, period of sustained engagement, disengagement, and reengagement. They identified five attributes that are relevant to point of engagement and reengagement: aesthetics, novelty, interest, motivation, and specific or experiential goal. Ten attributes were identified as attributes of period of engagement: aesthetic and sensory appeal, attention, awareness, control, interactivity, novelty, challenge, feedback, interest, and positive affect. Six attributes were identified as disengagement attributes: usability, challenge, positive affect, negative affect, perceived time, and interruptions.
Based on our literature review, we found that there is a lack of a unified understanding of user engagement in the online context. As suggested by O’Brien and Toms (2008), attributes of engagement may differ across different applications. In this research, we are interested in the attributes of user engagement in educational computer gaming.

**RESEARCH METHODOLOGY**

We conducted in-depth interviews with subjects who have experienced engagement with ECGs. We use the Grounded Theory (GT) approach, which provides a systematic approach to guide researchers in gathering and analyzing data, to develop a “grounded” understanding of the phenomenon of interest based on the empirical data collected (Strauss and Corbin, 1998). We use the three GT coding procedures outlined by Strauss and Corbin (1998) – open coding, axial coding, and selective coding – to analyze the qualitative interview data collected to develop a model on user engagement with ECGs.

**DATA COLLECTION**

We used the in-depth interview method based on the guidelines provided by Strauss and Corbin (1998) for data collection. We first developed a set of semi-structured interview questions and included in the interview script the definition of educational games as: (1) a game that teaches a certain subject, concept or topic, (2) a game that reinforces or furthers one’s intellectual pursuit in an area or discipline, or (3) a game that assists people in learning a mental skill as they play the game (i.e., physical and motor skills are excluded).

Our interviewees were asked if they have experience with ECGs, and if they indicated so, we asked them to provide the name of the ECG that they found most engaging. We then used that game as the subject of the interview to elicit concepts related to their engaging experience. We followed the standard interview script that we have developed to conduct each interview but maintained flexibility in probing and responding to interviewees.

**DATA ANALYSIS**

We interviewed twenty-one subjects who voluntarily participated in the study to share and describe their engaging experience with ECGs. All of the subjects are within the age range of 19 to 25 years. Nine females and twelve males participated in the study.

**Coding Procedures**

Open coding, axial coding and selective coding were used to analyze the data.

**Open Coding**

Open coding is the first step in the coding procedures where conceptualization of the phenomenon begins. Data are broken down, closely examined, and compared in this coding procedure.

There are three main steps in open coding: (1) naming concepts, (2) defining categories, and (3) developing categories in terms of properties and dimensions. The first step of this procedure, conceptualizing (naming concepts), refers to the process of labeling every phenomenon that emerged in the data. This step also involves grouping similar events, happenings, and objects under a common heading by examining their common characteristics/meaning. Strauss and Corbin (1998) suggest using a method called microanalysis where detailed line-by-line analysis is carried out to generate initial categories and suggest relationships among the categories.

The next step of open coding is to discover and define categories. It involves taking each concept that is derived from the first step and grouping these concepts under more abstract higher order concepts called categories. Categories can be found through pooling and grouping concepts, reviewing the literature review, or identifying vivo codes. Categories can originate from a pool of concepts that are discovered in the data. We use this method in discovering categories in our study because it is a less biased method than the literature review and vivo code methods. Although literature review is a relatively easy method to discover categories (since it involves identifying rather than generating concepts/categories), it has the disadvantage of possibly introducing biases in interpreting data. Vivo coding is another way to discover categories where researchers identify terms that frequently appear in the data.

The last step of open coding is to develop categories in terms of their properties and dimensions. In this case, we developed categories based on their properties and dimensions, which further assist us to relate all the categories when proceeding to the second step of the coding procedures. In this step, researchers can also develop subcategories to support and explain higher-level categories.

**Axial Coding**

Axial coding is an act of relating categories to subcategories based on the comparisons of their properties and dimensions (Strauss and Corbin, 1998). It is to resemble all the data that was fractured during the open coding process. The process of linking these categories is no longer descriptively indicated but should be conceptually defined. Our understanding of user engagement developed in this study follows the paradigm model suggested by Strauss and Corbin (1998) that can help to answer why, how, when, where and what questions. The paradigm model consists of three main components: conditions, actions/interactions (or characteristics), and consequences. Conditions refer to a set of events that cause situation/issues/problems related to a phenomenon and also help to explain why and how a phenomenon happens. Actions/interactions explain the
event that takes place in the phenomenon. Consequences describe changes of any action in the process that affect the phenomenon and consequently explain the phenomenon in a more comprehensive structure.

Selective Coding

Selective coding is the last step of refining and integrating the categories that emerged from open and axial coding. In this step, a central category should be chosen to pull all the categories together to form an explanatory whole. Concepts can then be integrated into the chosen core category and conceptually explained using a diagram or a storyline. The theory that emerged from the coding procedures should be continually reviewed to ensure that it is both consistent and logical.

PRELIMINARY FINDINGS

We categorized conditions, characteristics, and outcomes of user engagement as three top-level categories.

Under conditions of engagement, motivation emerges from the data as a key factor that led users to play and become engaged with ECGs. Both intrinsic and extrinsic motivations are relevant. Intrinsic motivation is based on self-generated motives by the users. Extrinsic motivation refers to factors that are generated from the external environment such as the game itself and the social environment.

Characteristics of engagement can be broken down into three aspects: affective, cognitive, and behavioral. Affective aspects of engagement include self-rewarding or autotelic experience, feeling of wanting to play non-stop, feeling of enjoyment, and continued interest. Cognitive aspects of engagement include goal accomplishment, (non-)awareness of environment, time distortion, focused concentration, immersion, locus of control, loss of self-consciousness, and vivid memory of the game. Behavioral aspects of engagement include being locked-in to the game, non-stop playing, responding only to physiological needs, or even becoming unaware of physiological needs. Note that it is not necessary for an engaging experience to fulfill or satisfy all of these characteristics as every learner may experience engagement in a different or unique way. Our findings suggest that subjects were emotionally and cognitively involved when they were engaged in a game.

Outcomes of engagement emerged in two forms: affective feelings and sense of self-pursuit. Both positive and negative feelings emerge from the engagement experience. Subjects also indicated that they felt a sense of achievement, enrichment, and accomplishment. One subject even indicated that s/he gained self-esteem.

Sense of curiosity is a concept that emerges in all three categories, i.e., conditions, characteristics, and outcomes of user engagement. Some subjects indicated that they felt a sense of curiosity before they started playing ECGs (e.g., curiosity of the game storyline). Curiosity is also a characteristic of engagement (e.g., curiosity of one’s potential achievement in an ECG). Some indicated that they felt a sense of curiosity even after an engaging experience (e.g., by asking ‘what if’ and ‘what next’ questions about the ECG).

EXPECTED CONTRIBUTIONS & FUTURE RESEARCH

Our research explores the nature of user engagement with ECGs to develop a deeper understanding of the phenomenon. We plan to continue data collection to derive a comprehensive model to explain and predict user engagement with ECGs. Through our research, we also hope to offer design considerations and guidelines on designing highly engaging ECGs.

User engagement is an important topic and phenomenon in IS use. To design systems (or games) that are engaging to users, we need to take into account not only the user, but also the task/context. In this research, we focus on ECGs as the category or type of systems and education as the task, and interviewed users on their experiences. In future research, we hope to assess different aspects of game design (including world design, system design, content design, level design, and user interface design) on user experience to provide specific guidelines on design considerations. We also hope that our research will contribute to the education arena by offering suggestions to improve education through computer gaming.

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