Interest in Citizen Science

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Abstract: Video games may be useful for improving student interest in pursuing STEM content areas. In order to explore their potential, reliable measures of interest must be developed that are appropriate to the game and that are theoretically motivated. This study presents pilot data of a survey that is being developed to measure interest associated with the game *Citizen Science*.

Video Games for Interest Development

Video games have been proposed as potentially useful tools for learning, especially in science, technology, engineering and mathematics domains (National Research Council, 2011). Specifically, games may be useful for getting students to engage with and learn complex scientific systems (Clark, D'Angelo, & Schleigh, 2011), to learn concepts more intuitively (Squire, Barnett, Grant, & Higginbotham, 2004), and to participate in scientific habits of mind (Duncan & Steinkuehler, 2009). Additionally, video games have been considered for their potential to deliver widespread, high-quality STEM education to American youth given their current popularity and distribution, as well as their tendency to use good learning principles (Mayo, 2009; Gee, 2003).

Given research suggesting that games can be powerful motivators for learning (e.g., Malone, 1985; Lepper & Cordova, 1990), and the close relationship between motivation and interest (Schiefele, 1991), the proposed use of video games to promote player's interest in science topics is plausible, though currently underdeveloped. Squire (2004; 2005) for example, documents examples of students' engagement with the game *Civilization* in a classroom setting, and suggests that good commercial video games can be used to pique students' interest in academic topics like history or geography. Squire however, does not define interest development in the context of *Civilization* with respect to definitions of interest presented in research literature (e.g., Hidi & Renninger, 2006). Though the compelling experiences that good video games provide for their players may help to develop student interest generally in related topics or activities, resulting in improved performance on related academic tasks (Steinkuehler, 2010), targeted development of topical interest is still relatively unexplored.

Defining and Measuring Interest

In order to determine whether and how games promote interest development, a definition and model of interest development must first be articulated. As defined by Hidi & Renninger (2006), interest is considered to be "the psychological state of engaging or the predisposition to re-engage with particular classes of objects, events, or ideas over time" (page 112). It can vary in depth and complexity and is defined by four phases: 1) triggered situational interest, in which the individual attends to learning content, yet requires outside influences to help sustain interest; 2) maintained situational interest, in which the individual recognizes the value of the content and engages with it for longer periods, yet still requires external supports; 3) emerging individual interest, in which the individual begins independently reengaging with the material; and 4) well-developed individual interest, in which the individual regularly engages with the material in more depth (Renninger & Su, 2011; Hidi & Renninger, 2006). Increasing student interest in science domains is important, as improved interest has been linked to improved measures of student performance. For example, when asked to connect science content that they learned in class to their personal lives, students who had low expectations of success in the course saw improvements, both in reported interest and in course grades (Hulleman & Harackiewicz, 2009).

The goal of this research was to begin the development of reliable measures of interest development in a video game context in order to inform existing theories of interest development and to improve on the design of the game intervention used. We envision evidence of player interest development in a video game context to eventually rely on sources typically used to study interest, including surveys, extra-curricular activities, interviews and observations. Additionally, because digital actions can be logged, we expect to coordinate in-game and related activity with these other sources of evidence to develop models of student interest development across contexts. Our first step in this process, however was simply to modify a survey that had previously been used reliably, so as to validate our own items and measure interest in topics related to our educational game, *Citizen Science*.

Methods

Citizen Science is an educational adventure game developed with the goal of teaching students about lake science and civic action especially regarding issues that currently affect Madison, WI. As players progress through the game, they interact with non-player characters (NPCs) and a simulation of Lake Mendota, collecting evidence and making arguments in order to convince the NPCs that they should act to improve the lake's health. As the player completes arguments, the narrative advances and new areas and arguments are unlocked. The game is over when the story and all nine arguments have been successfully completed.

In this study, 106 undergraduate students enrolled at large university in Midwestern United States played Citizen Science for approximately forty-five minutes in order to become acquainted with the content that the game addresses. After playing the game, players were asked to complete a seven point Likert-scale interest survey related to topics addressed through game-play and regarding the game itself. The survey was a thirty-one-item questionnaire designed to measure triggered situational interest in the session (an immediate interest response, or "catch") and maintained situational interest (situation-supported interest) related to civic participation, lake science, and video game play. Items were presented in a random order per subject.

Survey items were adapted from existing questions developed by Linnenbrink-Garcia et. al. (2010) that were developed to measure situational interest in academic settings. Since the original interest survey addressed psychology content taught in a classroom context, the questions were modified to instead assess player interest in lake ecology, citizen action (or activities that improve the health of local lakes), and video game play, both in classroom and non-classroom settings. Specifically, questions pertaining to classrooms or teachers were dropped, and question topics were altered to reflect game content. A question such as "I think the field of psychology is interesting," for example, would be changed to "I think the field of lake ecology is interesting" (see Table 1). Upon completion of data collection, six participants were removed from the dataset due to session irregularities (e.g., answering quickly and down a column), leaving an N of 100.

	Sample Question	Number of Questions
Lake Ecology	The information I learned about lake ecology is important.	9
Civic Action	I think learning about what I can do to improve the health of local lakes is interesting.	9
Educational Video Game Play	I am excited to learn through playing educational video games.	8
Recreational Video Game Play	In my opinion, playing video games is important as a leisure activity.	2
Citizen Science (the game itself)	I enjoyed playing Citizen Science.	3

Table 1: Survey Makeup and Example Questions

Results

Reliability statistics for each category to determine which items could be dropped for greater measurement reliability (see Table 2). Cronbach's Alphas for each survey section were above .8.

An exploratory factor analysis using maximum likelihood estimation for two to five factors and oblique (Promax) rotation was also performed. RMSEA was initially poor (.107) likely due to small sample size, and suggested two underlying factors related to either the content introduced in the game (i.e. lake ecology or civic action) or game play (i.e. educational, recreational, and Citizen Science). Three content items and four gaming items were removed due to similar loadings across both factors and wording. For example the content question, "I can apply what I learned about lake ecology to real life" was removed because in the one hour of game play allotted, participants may not have progressed far enough in-game to cover sufficient content regarding lake science that they could apply to their lives. Questions that were particular to Citizen Science were also removed, such as, "I enjoyed playing Citizen Science." These questions were likely capturing something like the situational interest of the game

play experience, which in turn may have been affected by an interest in not offending the game's developer/researchers. Removing these items improved model fit from $\chi^2 = 865.110$ (404) ($p < .000$) to χ^2 (481.610), $p < .000$. A modified version of the survey then, could include either 28 questions total or 15 questions that addressed in-game content (Appendix A).

Discussion and Conclusion

Substantially more work needs to be done if we are to take seriously the project of using games to measurably improve student interest in STEM disciplines. The study presented here was a pilot, and as such, includes many limitations. For example, the relatively short amount of time students were exposed to the game (approximately one hour), likely impacts the game's potential to develop more than triggered situational interest. Because interaction with the game was relatively short, any maintained situational interest captured by the survey will likely be minimal at best and individual interest is likely influencing survey responses, especially with respect to the educational content. Survey respondents (undergraduates) were also not the intended game audience (upper elementary school students) and items may need further modification depending on reading levels. Given the modifications to the survey that we made (i.e. the questions dropped), we suspect the items will be useful in addressing student interest in topics covered within the game, but developed outside of game play. Future use of survey results may be as covariates or pre-test measures that help to better characterize the player and the different interests that students bring to the table, which in turn may influence game play and learning outcomes.

Because interest in a content area often leads to a deeper understanding of the material, and can help shape future development, measuring the effectiveness of particular games in promoting interest is useful. Understanding how to measure the pathways of interest development can not only result in improving theories of interest development, but can also inform the design of educational software. Applying interest theories to educational video games raises at least two challenges, however. First, when used in conjunction with a course, the target domain for interest development may not be the only content included in the game. Video games, especially ones that are not designed specifically for the purpose of classroom use, often contain elements of fantasy and require their players to suspend their disbelief. Further, games include models, which are inherently inaccurate representations of reality. Players are required to interpret the content presented, and do so based on their inherently varied current social, political, and cultural positions (Devane & Squire, 2008). Because video games frequently focus on creating an enjoyable player experience they may purposefully simplify the educational material or embed it within a narrative so as to make the game more enjoyable or coherent. Measuring and tracking interest development in the context of non-content may be useful for advancing our understanding of interest development and for informing design modifications that could be made to the game.

Second, interest development is inherently complicated. It can develop along unexpected pathways that are not necessarily related to the immediate content or context (Disessa, 2000; Barron, 2006). When used in a curriculum context or for college students, *Citizen Science* may clearly relate to particular content, however, players may not follow up on their interests for many play sessions or may do so in other, difficult to track ways. The issue that this study raises is one of selecting an appropriate unit of analysis – if interest must be topic specific and games introduce multiple topics simultaneously, what topics are salient to players and does context matter? Given this challenge, a practice oriented model (Azevedo, 2011) rather than the four-phase model may be more useful, given that the four-phase model assumes that interest is relatively stable and topic-specific and a practice approach focuses more broadly on associated activities (e.g., gaming) rather than on content. Adopting a practice perspective, while potentially more accurate, requires rectifying a targeted interest development intervention with more naturalistic ways of playing, however and may not be appropriate for more formal learning environments.

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