Finding Frogs: Using Game-Based Learning to Increase Environmental Awareness

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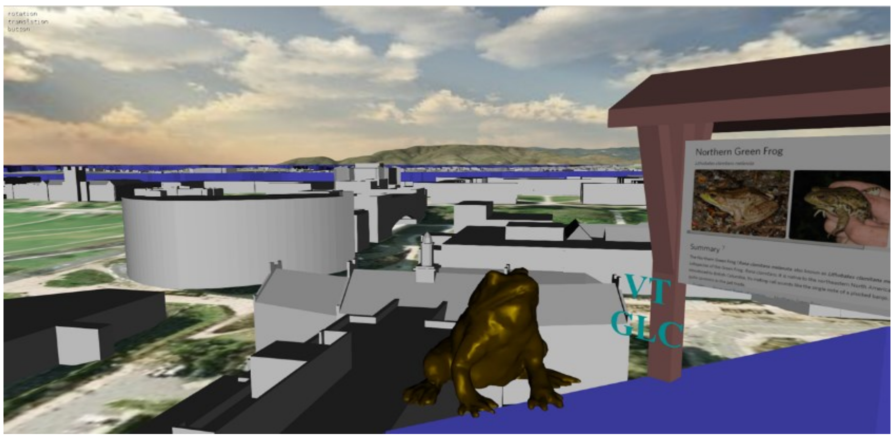

Figure 1: 3D Blacksburg with Stroubles Creek GIS and Frog Information Stations.

ABSTRACT

We explored how game-based learning (GBL) can influence environmental awareness in undergraduate college students using an original 3D application. GBL approaches posit that learners who interact with educational materials with playful and dynamic tasks will learn better. In a two-condition laboratory experiment, participants (N = 84) interacted with game and non-game versions of a 3D GIS interactive visualization of Blacksburg, Virginia, containing information about local waterways. A questionnaire assessed enjoyment, general environmental awareness, local environmental awareness, and awareness of local environmental installations. Participants who interacted with the game version reported more enjoyment of the application than participants using the non-game version, and exploratory analyses suggested that the game-based version induced greater interest in seeking more information than the non-game version. Lessons learned from outcomes may inform development of future environmental campaigns employing game-based learning.

Web3D '17, June 05-07, 2017, Brisbane, QLD, Australia
© 2017 ACM. ISBN 978-1-4503-4955-0/17/06…$15.00
DOI: http://dx.doi.org/10.1145/3055624.3075955

CCS CONCEPTS

• **Human Computer Interaction → Visualization**; *Virtual Reality*; Empirical Studies in visualization; Geographic visualization

ADDITIONAL KEYWORDS AND PHRASES

Game-Based Learning, Environmental Awareness, Education

ACM Reference format:

Nicholas Polys, Jessica Hotter, Madison Lanier, Laura Purcell, Jordan Wolf, W. Cully Hession, Peter Sforza, and James D. Ivory. 2017. Finding Frogs: Using Game-Based Learning to Increase Environmental Awareness. In *Proceedings of ACM Web3D 2017 conference, Brisbane, QLD, Australia, June 2017 (Web3D '17)*, 8 pages.
DOI: 10.1145/3055624.3075955

1 INTRODUCTION

The dynamics of accomplishing effective environmental sustainability campaigns and policy are complex, requiring a nuanced understanding of local stakeholders to be effective at the community level (Blake et al 1999). Awareness and attitudes about local environmental issues play an important role in environmental behavior, as local environmental activity is the most effective way for most individuals to have an impact on sustainability and local environmental involvement predicts other sustainable activity such as purchasing behavior (Lee et al 2010). Surveys of local environmental awareness have identified mixed levels of knowledge and perceptions of responsibility within communities (McDaniel et al 2005; Sennes et al 2012).

There is empirical evidence that educational program interventions focused on local environmental education may be useful in improving environmental knowledge and awareness, but such effects may be moderated by socioeconomic background factors (Fisman 2005). One potential avenue for broadly increasing local environmental awareness and behavior is game-based learning (GBL), which is centered around the idea that integrating game tasks and activities into real-life learning situations can increase engagement, cognitive processing, memory, and other learning responses (Prensky 2001). We applied a GBL task to an interactive 3D model of local waterways of environmental concern, then tested the effectiveness of the task in affecting a number of outcomes related to the game experience and environmental outcomes and behavior.

We built an Extensible 3D (X3D) platform with GIS data to promote awareness of Stroubles Creek, a local waterway that is underground for large portions of the town of Blacksburg and campus, and is listed as 'impaired' by the state (Figure 1). Called 3D Blacksburg, this tool is a three-dimensional GIS visualization of downtown Blacksburg and the Virginia Tech campus, with Stroubles Creek depicted as a bright blue ribbon circulating throughout. Because the stream is underground and invisible to most inhabitants, we used the 3D Blacksburg virtual environment to represent the stream centerlines and flood plain throughout town. We also developed a version of the 3D Blacksburg platform that includes a game component, the theme of which involves finding frog statues that are part of a physical art installation along the creek in the town of Blacksburg.

Using the 3D Blacksburg platform concepts as a guide, we then conducted a randomized controlled laboratory experiment exploring the broad research question: Would students be more influenced in their awareness of local environmental issues by interacting with the game environment than the non-game version? We designed a one-factor experiment with two conditions—3D Blacksburg with 'game' and 'non-game' interactions. After participants recruited from the Virginia Tech student body interacted with one of the two conditions as per random assignment, they completed a questionnaire to measure their perceptions of using the 3D visualization and a number of dimensions of local environmental awareness.

2 BACKGROUND

2.1 Environmental Status of Stroubles Creek

A culverted creek lies far beneath the pavement of some of the busiest corners of Blacksburg, Virginia, and the Virginia Tech campus. This waterway—Stroubles Creek—stretches twelve miles in total and extends to the New River, which is the area's source of drinking water, and eventually into the Gulf of Mexico. Stroubles Creek is a fresh water source that attracted the first Native American and white settlers; however, major portions of the upper stream have been covered and diverted underground since as the town developed (Parece et al 2010).

In the almost four hundred years of human habitation of this watershed, Stroubles Creek has gone from being the main source of drinking water to being polluted by raw sewage, chemical spills, and impacted by the aftereffects of an increasing population (Parece et al 2010). Much of this population is transient undergraduate students who come to Virginia Tech for four years and then leave, unaware of the fragile ecosystem beneath their feet. Daily carelessness, littering, pollution, and runoff exacerbate the stream's problems. Where the creek is completely underground, it does not have the benefit of sunlight and soil to help filter out these contaminating effects.

Nearly five miles of the twelve mile creek have been designated as 'impaired' for sediment and seven miles for bacteria by the Virginia Department of Environmental Quality. Stroubles Creek's water quality has been monitored by the state since 1994, and health assessments are made every two years. Those assessments reveal a decline in the number and variety of organisms living in and around the stream's bottom, weakening the creek's health (Thorton et al 2014).

2.2 Innovative Approaches to Education

The game-based learning approach posits that in learning situations, integrating games into real-life settings makes users more engaged (Prensky 2001). Studies of GBL have most often focused on the transfer of game-learning to external tasks, enhancing cognitive processes, the effect of playing time, and general effects of gaming on players (e.g., the possibility of increased aggression) (Tobbias et al 2014). Games across the spectrum, from board games to virtual reality, can test learning and information retention (Morrison 2015). While research on the benefits of GBL for enhancing cognitive processes indicates some promise, research is less conclusive on the transferability of GBL to external tasks (Tobias et al 2014).

Prensky (2001) explores the role of games for educational and training purposes, specifically in business and government settings. He argues that learners have changed, and digital GBL uniquely meets the needs of current and future generations, even more so than powerful media like television. Prensky also argues that digital GBL is especially motivating, since it introduces the element of "fun," and that its versatility allows it to be used for almost any setting and purpose. He argues that digital GBL has immense potential, since games have the "holding power" of television, but are much more engaging, adaptive, learner-centered, and easy to make. Prensky outlines 12 elements that make digital games engaging and explains 6 specific reasons as to why and how digital GBL works; all of which provide us compelling reasons to pursue the importance of games in raising awareness/increasing knowledge of environmental issues. In the future, Prensky argues, the quality and prevalence of games will only increase.

Al-Azawi, Al-Faliti, and Al-Blushi (2016) used a comparative study to explore the difference between education games, GBL, and "gamification" in education. They clarify distinctions between GBL and similar concepts, such as "gamification" and the broad idea of education games. They define GBL as the stealth-use of games to "enhance the learning experience" (p. 134) and teach concepts that are normally boring, complex, or otherwise inaccessible by most audiences. The rewards of GBL are intrinsic, and the true motivation is playing the game itself. "Gamification," on the other hand, uses game-like elements and "takes the entire learning process and turns it into a game" (p. 134). Its rewards system involves experience points, which can be collected and then used to "level up." Conversely, educational games are used to teach a specific concept or subject, and its rewards system involves scoring points like a traditional game.

Modern video games have come to incorporate many of the best practices known to those interested in learning, according to research by Eichenbaum, Bavelier, and Green (Eichenbaum et al 2014). In their survey of literature related to video game play and learning, they found enough research to hypothesize that repetitive game play goes beyond just improved performance, but can fundamentally change the way players perceive their environment and learn.

Thus, if gaming can change the way players see the world, perhaps playing a game that reconstructs a player's real environment can influence how the player perceives that environment later. In an exploration of playing video games as an art experience, if the setting of a game reflects reality, this "naturalistic representation prompts meta-reflection" [Folkerts 2010, p. 14]. Even within the limitations of a game that models Stroubles Creek, this type of informal learning environment may be able to disrupt the entrenched patterns of behavior. However, for learning to be effective, the gaming experience must be a pleasant one; in some cases, there is a need for games to be challenging and to have a win/lose component so that players are invested in the experience.

2.3 Digital Realities and Learning Tools

Virtual reality (VR) can be used as an effective method for students to learn (Onyesolu et al 2013). The authors rely heavily on social constructivism as a means to explain why VR is effective for learning. Social constructivism sees learning as a social activity. Therefore, something as immersive as a virtual reality or three-dimensional model will involve the learner in a collaborative and social medium.

People who are more apt to learn by involving themselves socially can benefit from immersive technology; thus, VR may be especially useful, "in situations where exploration of environments or interactions with objects or people is impossible or inconvenient, or where an environment can only exist in computer-generated form" (p. 45). This is important for large-scale modeling and objects which are otherwise unable to be seen. Augmented reality may also have untapped educational potential for learners of all ages (Radu 2014). In both augmented reality and virtual reality, the potential for engagement and interest is higher because both technologies are relatively novel. Both can be effective for better learning performance, motivation, engagement, and positive attitudes (Onyesolu et al 2013). Although this research is related to how participants might interact and be influenced by 3D Blacksburg, no specific questions were asked about the GIS environment.

3 IMPLEMENTATION

3.1 Geospatial Data

Our source data was in ESRI GIS formats and the ArcScene application. To use these assets, we wrote a set of exporters and data processor scripts. The preparation of this set of X3D terrain data was the same as that as described in Kim et al (2015). Watershed data (stream center line and flood plain polygons) were translated to X3D Extrusions and colored blue (Figure 2).

The X3D Blacksburg town model also includes 3D building models constructed to OGC's CityGML LOD specification. Geo-referenced campus buildings were constructed as IndexedFaceSets and included rooflines; 3400 town buildings were generated as Extrusions from their footprint and height as recorded in the county GIS database. Prior to final publishing, these Extrusions were converted to IndexedFaceSets. There were also textured SketchUp models of several downtown buildings included as an X3D Inline scene.

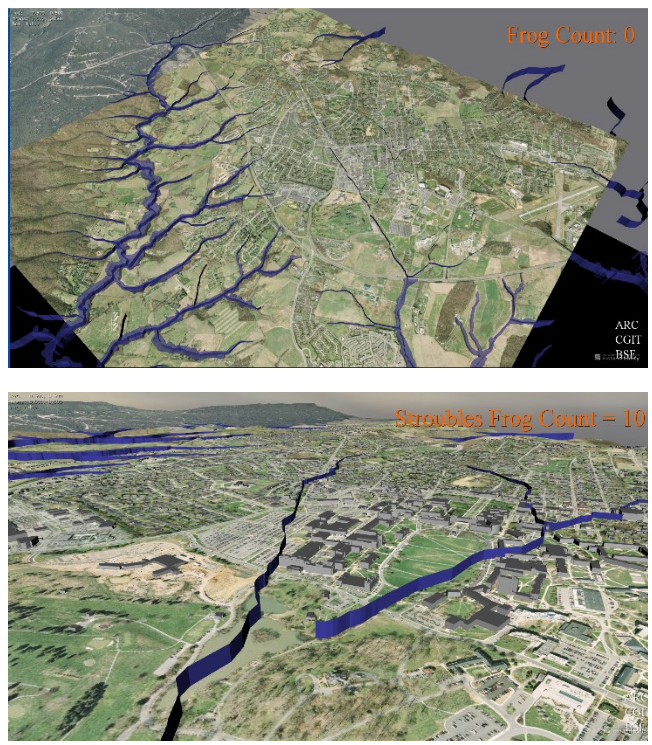

Figure 2 : X3D Blacksburg extent for this experiment.

3.2 Interactive Scene Graph

The mashups of data used in this project can be seen as a natural evolution from the X3D versions described in (Tilden et al 2011) and (Polys et al 2016). In this case, we created a master scene with the user interface and game logic and put all the assets under Switch nodes as Inlines. At several locations around town, we put up large menu buttons, which enable users to toggle the visibility of the watershed, the downtown building, the campus buildings, and the town buildings.

For our public-facing version, all layers were visible by default. One of the 16 frog sculptures was 3D scanned and processed to produce an X3D model with a simple bronze material added. We used this model along with a trail kiosk model as a basis to create information stations that included the frog and information about the local species (Figure 1). We placed 16 of these scenes (as Inlines) around town anywhere the creek crossed a major road or went underground. These info-stations were under LODs so that low-resolution versions would be displayed from far away. We added ProximitySensors at each location and programmed a Script to record each time a user got close enough to 'catch' a frog. For each frog caught, a prominent foreground read-out labelled "Stroubles Frog Count" was incremented (Figure 3).

3.3 Multi-Platform User Interface

We wanted this game to be accessible to a wide audience in a public installation or lab setting. We used the InstantPlayer X3D engine to run the game environment. InstantPlayer includes X3D extensions that make it easy to connect immersive VR devices. (i.e., Polys et al 2008). We used the built-in connection to USB devices to get events from a typical game controller. Using 3D games as an example, we mapped the two joysticks to orientation and position of the live (navigating) Viewpoint.

Figure 3: Score incremented upon proximity.

4 ASSESSMENT: LAB EXPERIMENT

4.1 Methods and Measures

4.1.1 Rationale, design, and hypotheses

The 3D Blacksburg application has been used for town planning and outreach; at the 2016 Virginia Science Festival, we had over 350 unique users 'hunt frogs' in our X3D world with a game controller (Figure 4). Stroubles Creek was marked with a large blue path throughout campus and town, even where it is underground and invisible. Frogs and information stations were placed throughout the stream's course. To further test the application's game-based learning potential, we decided to conduct a controlled laboratory experiment for more conclusive evidence regarding the unique effectiveness of the application's game-based learning elements on several outcomes related to the experience and consequent environmental awareness.

Our investigation was guided by these general hypotheses:

- ***Hypothesis 1*** **(H1)**: Participants will find the game condition more enjoyable than the non-game condition.
- ***Hypothesis 2*** **(H2)*:*** Participants in the game condition will report higher levels of general environmental awareness than participants in the non-game condition.
- ***Hypothesis 3*** **(H3)*:*** Participants in the game condition will report higher levels of local environmental awareness than participants in the non-game condition.
- ***Hypothesis 4*** **(H4)*:*** Participants in the game condition will report higher levels of awareness of local environmental installations than participants in the non-game condition.

4.1.2 Participants

Participants were full-time undergraduate students at Virginia Tech, with an age range between 18 and 34 years. The average age of the participants was 19.94, with the median being 19. Sex distribution of participants was fairly even, with 44 males and 39 females, with one participant not providing information about sex or gender. Participants were recruited to participate in the study for course credit. All recruiting and research procedures were conducted with the approval of a university Institutional Review Board.

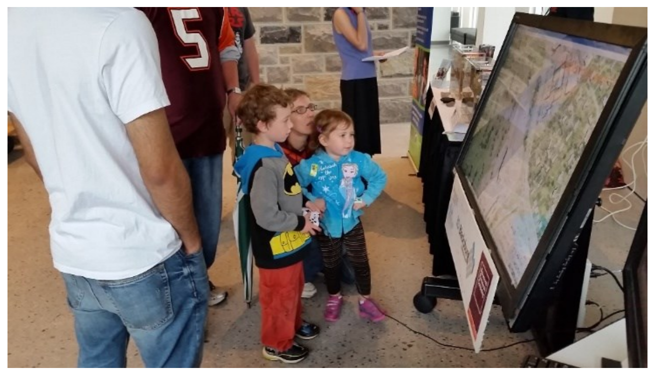

Figure 4: X3D Blacksburg Frog hunting game at the 2016 Virginia Science Festival.

4.1.3 Stimulus materials (IVs)

Participants were randomly assigned to use one of two versions of the 3D Blacksburg applications: a game-based simulation featuring tasks, and a non-game simulation with no tasks. The non-game simulation involved participants' interaction with 3D Blacksburg, allowing them to explore the virtual world freely with no guidance. The game-based simulation game was similar to the non-game condition, except that participants were given specific instructions on how to complete a game within 3D Blacksburg. The game was a scavenger hunt for 16 frogs placed along the creek channel, motivated by an intrinsic rewards system (no physical points given, and no competition with other players). The participants were instructed to find as many frogs as possible in ten minutes.

4.1.4 Outcome measures (DVs)

The four dependent variables we assessed were enjoyment, general environmental awareness, local environmental awareness, and local environmental installation awareness:

Enjoyment. Enjoyment was assessed with four Likert-type scale items (1 = "strongly agree," 7 = "strongly disagree;" some items reverse scored): “Interacting with the virtual environment was enjoyable,” “Interacting with the virtual environment was entertaining,” “I disliked interacting with the virtual environment,” and “Interacting with the virtual environment was a waste of my time.” These items were combined to form a single ‘‘enjoyment’’ index, which was reliable (Cronbach’s α = 0.8581).

General environmental awareness. General environmental awareness was assessed with six Likert-type scale items (1 = ”strongly agree” and 7 = “strongly disagree;” some items reverse scored): “I am generally aware of environmental issues,” “I am interested in environmental issues,” “Compared to other Virginia Tech students, I know a great deal about environmental issues,” “I worry about environmental issues,” “Understanding environmental issues is not important to me,” and “I am unfamiliar with most environmental issues.” These items were combined to form a single ‘‘General environmental Awareness’’ index, which was reliable (Cronbach’s α = 0.8096).

Local environmental awareness. Local environmental awareness was assessed using eight Likert-type items (1 = ”strongly agree” and 7 = “strongly disagree;” some items reverse scored): “I know what Stroubles Creek is,” “I can point to Stroubles Creek on a map,” “Blacksburg pollution affects Stroubles Creek,” “Virginia Tech students should care about Stroubles Creek,” “I want to seek out more information about Stroubles Creek,”“I consider Stroubles Creek an important part of the Blacksburg ecosystem,” “Stroubles Creek is of minor relevance” and “I don’t plan on telling my friends about Stroubles Creek” These items were combined to form a single ‘‘Local environmental awareness’’ index, which was reliable (Cronbach’s α = 0.7811). Other items asking about the location of Stroubles Creek, possible pollution source, and other specific aspects of the area were included in the questionnaire instrument, but not analyzed here.

Local environmental installation awareness. Five Likert-type scale items were used to assess local environmental installation awareness (1 = ”strongly agree” and 7 = “strongly disagree;” some items reverse scored): “I know what the 16 Frogs installation is,” “I have seen the 16 Frogs installation,” “I want to seek out more information about the 16 Frogs installation,” “The 16 Frogs installation hasn’t come up in conversations with my friends,” and “The 16 Frogs installation isn’t of much interest to me.” These items were initially planned to be combined to form a single “16 Frogs Awareness” index, but reliability analysis indicated that the index was not reliable and thus likely to include items measuring more than one concept (Cronbach’s α = 0.4632).

Other measures. Other measures included five demographic questions including: “How old are you? (in years),” “Which gender do you identify with?,” “Are you a full-time student?,” “Which best describes your education status?,” “In which college are you pursuing your degree? (If double majoring, select the college of your primary major).”

4.1.5 Procedures

Data were collected via in-person laboratory experiment sessions on dedicated laptop computers with Xbox 360-style game controllers, with InstantReality used to run the 3D simulation. Participants took part in sessions in groups of up to four, with each participant assigned to a unique laptop computer station (Figure 5). When participants arrived at the laboratory facility, they signed in, signed an informed consent form, and were seated at a table arranged with four laptop computer station areas. Each station was equipped with a HP laptop computer running the Windows 8 operating system. Laptop computers were also equipped with Microsoft Xbox 360-style USB controllers.

Figure 5: Participant laptop computer station equipment.

The laptop computers were pre-arranged with the 3D environment already open. After reading a set of instructions, participants had ten minutes to explore their 3D environment, and a timer was set to measure time. After ten minutes, participants were instructed to stop their game playing, and experimenters closed out the 3D Blacksburg environment and opened an online survey instrument based in the Qualtrics application on the laptop computer stations. After participants completed their questionnaires, they were given debriefing forms outlining the general purpose of the study, thanked for their participation, and dismissed.

4.1.6 Data and Analyses

Questionnaires were distributed electronically via Qualtrics on the same laptop computers that participants used for the conditions. An anonymized data set and other study materials are available for download via the Open Science Framework at https://osf.io/b8u44/?view_only=d3db6c5f500b4b4b9ea1f86c0d05c7e4 Analyses were conducted using the SAS JMP statistical package. Independent samples *t* tests were used to test hypotheses with comparisons between study conditions for each outcome measure, as well as for exploratory comparisons.

4.2 Results

4.2.1 Enjoyment

H1 predicted that participants would find the game condition more enjoyable than the non-game condition. The game group’s average score on the enjoyment index (M = 4.39, SD = 1.32) was significantly higher than that of the non-game group (M = 3.49, SD = 1.04); $t(77.96)$ =-3.47, p = 0.0004 (Figure 6). Thus, H1 is supported.

4.2.2 General environmental awareness

H2 predicted that participants in the game condition would report higher levels of environmental awareness than participants in the non-game condition. The game group’s average score on the environmental awareness index (M = 3.12, SD = 0.91) was not significantly higher than that of the non-game group (M = 2.91, SD = 0.93); t(81.89) = 1.04, p = 0.1497. H2 is not supported.

4.2.2 Local environmental awareness

H3 predicted that participants in the game condition would report being more aware of Stroubles Creek than participants in the non-game condition. The game group's average score on the Stroubles Creek awareness index (M = 3.79, SD = 0.84) was not significantly higher than that of the non-game group (M = 3.54, SD = 0.84); t(81.99) = 1.37, p = 0.0879. H3 was not supported.

4.2.3 Local environmental installation awareness

H4 predicted that participants in the game condition would report being more aware of the '16 Frogs' installation than participants in the non-game condition. The game group's average score on the '16 Frogs' awareness index (M = 5.06, SD = 0.68) was not significantly higher than that of the non-game group (M = 5.07, SD = 0.81); t(79.34) = 0.03, p=0.5116. H4 is not supported.

4.2.4 Supplemental exploratory analyses

Considering the limited reliability of some planned index measures in the study, post-hoc supplementary analyses were conducted comparing scores across conditions for individual items. Because these tests were conducted post-hoc, for exploratory purposes, they should not be interpreted as support for a priori hypotheses and should be interpreted tentatively.

Among comparisons for each of the individual items in the index measures for which a difference between conditions was not observed, three significant differences between conditions were found. First, participants in the game condition (M = 3.71, SD = 1.31) reported greater intent to seek out more information about Stroubles Creek than those in the non-game condition (M = 2.88, SD = 1.29); t(81.98) =-2.93, p = 0.0022. Also, participants in the game condition (M = 3.57, SD = 1.15) reported greater intent to seek out more information about the '16 Frogs' installation than those in the non-game condition (M = 2.90, SD = 1.19), t(81.93) = 2.62, p = 0.0053. Finally, participants in the game condition (M = 5.60, SD = 1.47) reported that they could point to Stroubles Creek on a map significantly more so than those in the non-game condition (M = 4.98, SD = 1.69); t(80.41) = 1.79, p = 0.0383.

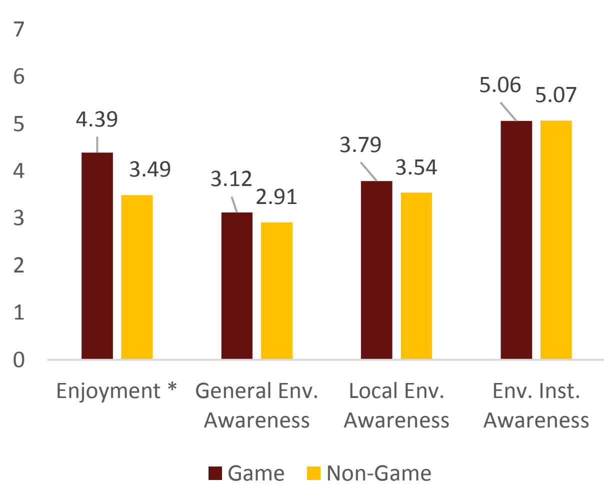

Figure 6: Summary of results.

4.2.5 Summary of results

Results indicate that playing the game version of 3D Blacksburg was significantly more enjoyable than roaming the world freely without an assigned task. However, these findings also show that the game did not have a consistently significant effect on environmental awareness, awareness of Stroubles Creek, or awareness of the '16 Frogs' installation. In exploratory supplemental analyses, the game condition had a significant effect on participants' intent to seek out more information about Stroubles Creek, their intent to seek out more information about the '16 Frogs' installation, and their reported ability to find Stroubles Creek on a map.

5 DISCUSSION

5.1 Implications

Results of this study may be useful for town stakeholders who want to inform their constituents about environmental issues related to Stroubles Creek; as our results determined significant relationships between the game condition and the individual index items of being able to locate Stroubles Creek on a map and wanting to seek out information about both Stroubles Creek and the 16 Frogs installation. This study also reinforces GBL as a legitimate and effective theory while not radically refuting or suggesting a reexamination of it.

Blacksburg has a daily population of over 50,000 people (Blacksburg 2014), with 31,090 consisting of Virginia Tech students (Virginia Tech 2016). For the most part, these students are unaware of the creek and its location. While a game may not inspire fundamental opinion changes about environmental issues, these findings show that a task-based game is an effective tool for cultivating interest. The results show that employing a GIS-based model of Stroubles Creek while incorporating a game element is a largely efficient way to generate interest in the topic.

A large implication of the study for Blacksburg is that may help in raising environmental awareness that could, ultimately, influence policy and planning decisions. As our results show that the game may inspire Virginia Tech students to seek out information about their community, it may be used as a learning tool for the entire Blacksburg community to raise awareness about the creek. This application of the research is perhaps the most practical, and could be used to bring about positive change in relation to potential issues directly affecting Stroubles Creek.

Outside of Blacksburg, this study can be used as a model for other municipalities with populations who may be unaware of local environmental concerns. Based on the results of this study, communities may want to consider using task-based games to educate their constituents' environmental issues. This study may add legitimacy to GBL as an effective approach, and does not call into question any main principles of GBL. This study also reaffirms the approach as a versatile one, able to be used in a unique setting [6] and one that is still relevant as games continue to be adapted as learning tools for complex concepts.

5.2 Limitations

Preexisting non-commercial 3D software was used in this study, which presented several limitations to the experimental stimuli. Although this allowed for greater customization, technical shortcomings led to some loss of control over stimuli performance. Bugs and crashes weren't uncommon, although these occurrences were not severe or frequent enough to impede data collection. There were also some bugs with the game controllers used to navigate the 3D environment, and there was most likely a learning curve for participants who aren't used to video game controls.

The game itself also had a learning curve, and it is likely that the size and placement of the frogs in the game condition influenced participant frustration or overall ineffectiveness of the game. Frustration was not specifically measured, although the enjoyment measure indicated that participants did enjoy the game to some extent. However, it might be useful to perform a pilot study or focus group in order to determine the game's overall ease of use. Depending on those findings, the game could be adjusted to make the game more enjoyable.

There were some limitations that were expected and unexpected of the physical lab environment. Whenever dealing with in-person experiments, it is expected that individual disturbances or outbursts can happen at any time. This study did not encounter any significant disturbances, but it might be beneficial to attempt this study in a more natural setting, or at least a more naturalized lab setting, in the future. Close quarters increased the chances for participants to contaminate the session (such as revealing their conditions or otherwise decreasing deception elements), and there is always a possibility of the close physical proximity to researchers influencing participants' questionnaire responses.

Another limitation is the lack of manipulation checks to rule out other causes for certain outcomes. The instruction sheets for the participants were drafted by the authors, but they were never tested for readability or ease of use. It isn't known if the instruction sheets effectively conveyed the task (or non-task) to participants, and the lack of manipulation check makes it uncertain whether all participants fully understood whether they were supposed to be completing a task or not. The greatest limitation to this study was the design and implementation of measures. All but one of the original indices used were found to be unreliable, and inconsistencies within these measures somewhat muddled the data. Moving forward, it would be beneficial to use more specific, established measures to conceptualized GBL and environmental awareness.

Finally, the authors recognize that the use of 3D Blacksburg in this study limits the applicability of its findings. While the idea of using GBL to explain complex issues is already an established use, the rest of these findings may be limited to local knowledge, interests, and attitudes concerning Stroubles Creek in Blacksburg, Virginia. As the sample is made up of typical college students this study cannot make definitive claims about uses of GBL to raise awareness for all environmental issues. Further research is needed to explore the nuances of how and when GBL and virtual worlds are an appropriate approach to such outreach.

5.3 Future Research

This study hints at how GBL approaches may influence motivations behind the desire to seek out information about factors affecting the environment. The findings that supported GBL as an approach are useful, but further research can be done to test the support of the theory in terms of setting and purpose. Studies that examine different ecological and environmental settings with various games or tasks associated with them can and should be done using a similar methodological approach as was used in this study.

Our finding that overall environmental awareness was not affected by either condition is an indication that more research should be done to determine the best methods of connecting to a person's beliefs and feelings about the environment. Considering oneself to be aware about the environment as a whole is most likely reflective of a particular worldview and set of beliefs rather than a typically malleable condition that can be changed in a laboratory setting. More research should be done to determine how people perceive the environment. With those findings, researchers can develop studies to test specific stimuli that may begin to affect change on people's attitudes at the psychological level.

The finding that indicated more enjoyment with the game condition over the non-game condition is important to gaming research. Studies using a similar game structure and methodological setup but adding in other variables, such as a narrative or characters, would be useful. These types of studies would add even more depth to GBL.

The most important area of research that could be explored based on this study is whether our findings are applicable outside of a college campus. Our findings were significant using a sample of college students while testing a local issue. A better test of these initial findings would be to replicate the study with different populations in Blacksburg. It would also be interesting to see how a similar community might be able to replicate the study using a game version representing their own environmental concerns.

ACKNOWLEDGMENTS

This work was partially supported by the Virginia Tech Institute for Creativity, Arts, and Technology SEAD program.

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