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Experiential Critical Thinking: Prototyping a Humanities Learning Module in VR

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Abstract. This work-in-progress paper discusses the potential role of virtual reality (VR) in humanities instruction. We describe the design rationale and first three prototypes of our proposed Experiential Critical Thinking platform (ECT). ECT is designed to exist in a hybrid learning environment, where digital, virtual, and traditional modalities of instruction coexist and reinforce each other. As a starting point for ECT, we have created two iterations of a VR experience connected to historical material about Che Guevara and the Cuban Revolution (CHE), with a third in development. CHE 3.0 emphasizes abstract and critical thinking about source material and argument construction.

Keywords: immersive learning, virtual reality, humanities, constructivist theory, virtual reality learning environments, kinesthetic learning, critical thinking, experiential critical thinking

1 Introduction

Effective and engaging learning is immersive. Decades of research on games has demonstrated the value of immersion into playscapes, and much of the literature on serious games and games for learning hinge on the same principle: if we can hold a student's attention, they will learn [5, 6]. VR presents an environment in which students are immersed, engaged and can be provided opportunities to exercise critical thinking skills, all of which contribute to better learning experiences. VR also allows for dynamic visuals, which lead to better cognitive process quality when compared with static text, further articulating a use case for VR as an educational methodology [8]. In this paper we describe the design rationale and first three prototypes of our proposed Experiential Critical Thinking platform (ECT). The goal of the ECT is to build an extensible, reusable platform for deploying humanities-oriented VR modules to support traditional instruction. As technology increasingly intersects with instruction, and as digital technologies become the primary technologies students and instructors will use, ECT

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explores the use of VR as a viable future platform for abstract thinking and higher education, making experiential research experiences possible even in large lecture classrooms.

2 Designing a Platform for Experiential Critical Thinking

Our vision for the ECT platform is that it will exist in a hybrid learning environment, where digital, virtual, and traditional modalities of instruction coexist and reinforce each other. Our working hypothesis is that students who experience part of their learning in VR will become better thinkers outside of it. Learning in VR may offer one of the rare instances where we can help students learn-by-doing at scale. Experiential learning ties the kinetic to the intellectual, connects familiar embodied actions to more abstract concepts, and we are particularly interested in seeing how VR can support students in having a physical experience of an abstract exercise, such as argument construction or idea generation.

VR is increasingly being used in teaching environments where practical, applied skills are part of the curriculum. This is why we see so much VR in medical schools and engineering schools. Teaching students anatomy on a virtual body is resource-saving, but it also allows students to operate on (virtually) live patients and observe immediate responses to their actions. The humanities are no less applied, but humanities instruction has become complicated by the fact that in the traditional large university classroom faculty have lost the ability to provide students with the iterative practice of research. Students are expected to perform research, but they do not get a lot of supervised practice. We are looking toward VR to provide us a space in which students and faculty can explore abstract ideas and practice them to do research and analysis. The context and infrastructure of VR may allow students to do this individually and provide faculty with data on their performance during the research phase – not just at its conclusion when the student submits their final paper. We are as motivated by the potential of VR as an experiential learning modality as we are by its potential to make personal attention and individualized teaching opportunities possible for every student, no matter what size of classroom they are in.

ECT is not a game, but it finds much of its intellectual rationale in constructivist theories of learning that have largely been applied in games [12-14]. Constructivism finds a natural ally in VR. If learning is a function of how the individual constructs meaning from their own experience, then VR has the potential to capture the complexity of reality through complete tasks, interaction, and instructional sequences [1]. This is how the VR experience has the potential to return the student to a traditional space of learning, where they are actively involved in the process of meaning and knowledge construction. We posit VR as a transformational education modality, not because we want to change how people learn, but because we want to return learners to a place of engagement and experience. Instructors and students today face a constant bombardment of media and digital content. There is strong evidence that this has led to shorter attention spans and lower engagement and critical ability in students [11]. To counter this, there is evidence that suggests that Virtual Reality Learning Environments

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(VRLEs) initiate interaction, immersion and trigger the imagination of the learner. When compared with non-immersive teaching, "immersive learners showed better retention of symbolic information and revealed more interest in a VR class" [8]. VR has also been proven to aid in the comprehension and assimilation of concepts [10]. A constructivist method of learning allows students think critically, making VR an appropriate vehicle for critical analysis and instruction [7]. Ultimately, just as "games allow players to be producers and not just consumers" the VR environment makes students active participants in the narrative and solvers of the problems we confront them with – VR, like games, subverts the passive environment of large classroom, and provides students with a space in which to fail safely, experiment, and learn. [5]

We are well aware that broad adoption of and investment in VR in the Humanities (or in higher education in general) won't happen until we can demonstrate that it can work in more than one context and for more than one class. It also must be shown to support the needs of a broad curriculum and the process of humanities inquiry. Educational VR for critical thinking and the humanities is not an obvious project for industry venture capital to invest in (unlike medical training in VR). These realities inform our design process, which is aimed at a VR system that is affordable and reusable. For these reasons, the ECT platform has the following design constraints: 1) Reusability: the platform has to be capable of being reused across a large landscape of humanities projects; 2) Plug & play functionality: the platform needs to be hardware and software agnostic, and needs to be architected in such a way that an instructor without coding experience can provide the data to the platform to create an original VR experience. From a user perspective, the design is immersive and uses known interaction modalities. Within ECT, students will be focused on exercising their cognitive capabilities, not on learning new content or figuring out the environment. From a developer/creator perspective, ECT is architected in such a way that content is easily organized in sections, allowing for the inclusion and creation of new content as well as the deployment of cognitive assessment and qualitative assessment mechanisms.

3 CHE Prototypes

As a starting point for developing the ECT platform, we have created two iterations of a VR experience connected to historical material about Che Guevara and the Cuban Revolution (CHE), with a third actively in development. The first two iterations of CHE were prototypes of educational VR that tested the usability of the concept itself. The current prototype emphasizes critical thinking about source material and is designed to invite students to assess and sort different types of historical information against a variety of hypotheses. The context for the experience is a speech by Che Guevara in which he presents the case for land reform in the aftermath of the revolution, and a return to prosperity for the island without US involvement. The VR experience is designed to fit into the classroom teaching of Professor Levy's introductory Latin American History classes. In the class environment, students will have read the speech and will have had lectures on the context of the Cuban revolution, the Cold War and the politics and economics of the late 1950's and early 1960's. The goal of the VR module is not

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necessarily to increase content knowledge of the historical moment, but to generate and model a critical thinking practice in the context of evaluating historical sources and their contribution to an argument.

3.1 CHE 1.0 & CHE 2.0

The previous builds were immersive and allowed the users to explore 360 degrees of the surrounding environment from a seated position. The content related to the Cuban revolution but included limited kinetic opportunities. We tested these builds for usability and user experience and these early prototypes showed indications of success. The first build was tested with 80+ users in an HTC Vive VR headset in early February 2017. The second prototype was tested with a similar number of users in early June 2017. The exit questionnaires show that users were able to draw conclusions based on the data and cite their reasoning after only a few minutes of exposure to the material in VR. We estimated users would spend 5 -15 minutes in the experience, and the average time in Che 1.0 was 7.4 minutes, in Che 2.0 it was 8.2 minutes. Many users expressed great satisfaction with the experience, and some referred specifically to the non-linearity of exploration that the experience allowed ("it has inspired me to think of the linearity of learning and the need for multiple forms of context), as well as how different it felt to experience the material in VR ("I felt like I was in a different realm").

Users in the first trial mentioned the discomfort of reading in VR, so we addressed legibility in Che 2.0. The feedback from Che 2.0 focused more immediately in the experience itself. The responses continued to be overwhelmingly positive, and feedback encouraged us to start increasing the levels of interactivity in Che 3.0. One clear result of the early tests that the experience generated a period of undivided focus for the user. The VR environment is rich in detail and is not connected to the web or to a smartphone, allowing users a rare moment of distraction free immersion that is very hard to replicate outside of VR. Part of what we will measure in the third build is how the interactivity and focus permitted in the VR experience contributes to the cognitive value of the VR experience, and whether that increased focus results in educational gains outside of the experience.

3.2 CHE 3.0

The latest prototype, CHE 3.0, is developed in Unity for the Windows Mixed Reality headset, which provides an immersive viewing experience and handheld motion controllers allowing navigation and interaction. Users enter a low-poly natural environment modeled after the Cuban jungle. The space is expansive, and they can walk around within the virtual space as much as their physical space permits. Greater distances can be covered via teleportation using the motion controllers. Historical data related to Che Guevara and the revolution is represented in this immersive world as a physical object, a "data block" that can be picked up and examined. Each data block maps to a quotation from an historical source related to the topic of the Cuban revolution. This exercise is designed to model agency within the information science structure. The traditional lecture class makes it difficult for students to practice what they are learning. We can

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lecture on the act of doing research, but it is difficult to explain to someone how to do it practically. The VR experience asks students to physically turn a piece of evidence around to analyze how it sheds light on a particular issue [Figure 1]. As students actively manipulate the data blocks, they internalize the cognitive message, namely what instructors mean by "research."

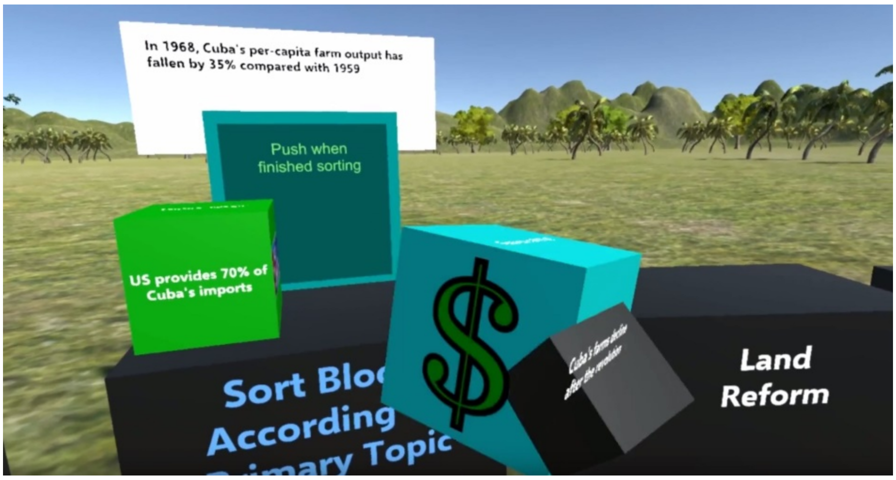

Fig. 1. CHE 3.0 screenshot: Data block held by user while sorting onto topic platforms

Users are led through a series of exercises in the experience where they are asked to sort the different data blocks in terms of topic, source, bias and role in constructing an argument for a specific hypothesis [Figure 2]. Each exercise builds on the previous one, exposing relevant information along the way. For example, at the start of the first exercise, the data blocks contain only the quote of historical source and the user is asked to sort them according to primary topic (US-Cuba relations, land reform, peasant life, economy). Following the completion of this exercise, the blocks are annotated with icons indicating their topics, and subsequent blocks added to the environment arrive with icons already in place. In this manner, the user gradually builds an understanding of the data and is then able to use it to form high quality arguments. The learning objectives for the experience are as follows:

- A good argument is constructed of relevant points of data.
- A good argument draws on data from a variety of data sources.
- A good argument is aware of the bias of the data sources.
- An argument is constructed to support a hypothesis, not a fact.
- A good argument martials relevant, varied & unbiased data to support a hypothesis.
- The hypothesis has to be a point of contention to support an argument (it should be feasible to argue the opposite of the hypothesis)

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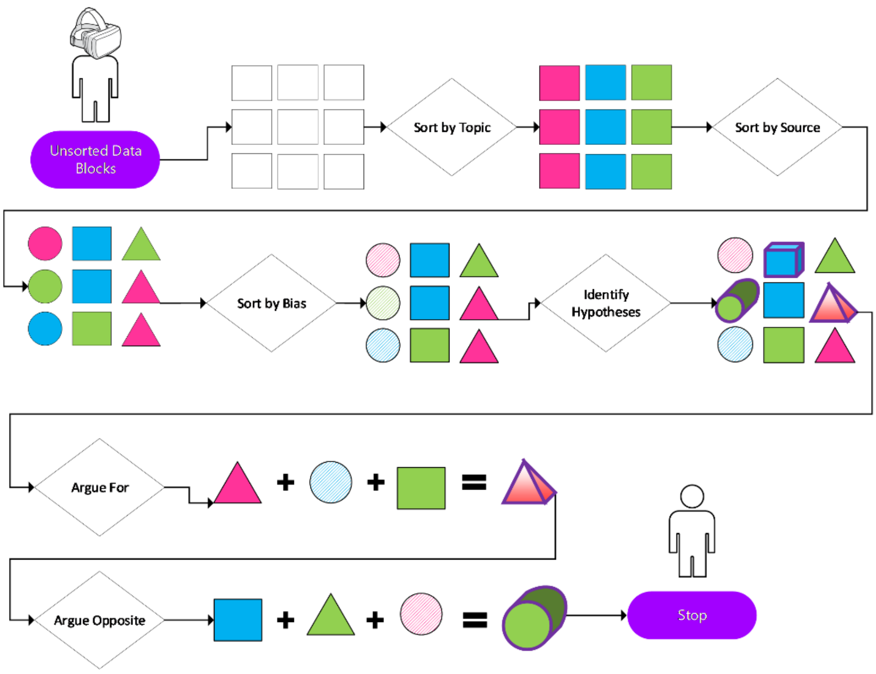

Fig. 2 Interaction flow for CHE 3.0

By putting students in an environment in which they physically build an argument through the act of assessing and evaluating multiple sources, we are modeling the research process. This process is similar to the explorations that can happen face to face in a small seminar classroom but is impossible to manage in a large lecture classroom. It is as difficult to teach someone to drive by lecturing them about it, as it is to teach students how to do research by lecturing about it. This VR experience aims to be an example of kinetic, immersive, experiential learning at scale.

3.3 Evaluating Learning Outcomes

A key objective of our prototyping is to contribute to a better understanding of the relationship between immersive VR and higher level cognitive processes. We are developing a testing strategy that includes measuring user feedback, physical data from users, and retention and activation of core concepts outside of VR. Through the first two iterations we tested our hypothesis with over 150 students and began to gather data about student interactions and the impact on classroom performance. An open question in VR is how to assess the extent to which participants are interacting with and attending to the content and how this contributes to learning outcomes. Assessing the relationship between what the user looks at and does and connecting that to other qualitative outcomes outside of VR gives us insight not only about how VR can help educate in the humanities, but how we want to design a humanities-oriented VR experience for maximum effectiveness.

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Our next testing stage focuses on collecting and analyzing physical information about participants in the VR module. There is strong evidence that we can "measure" cognitive engagement through eye movement and the parasympathetic nervous system, and we intend to collect and analyze this data in partnership with our colleagues in neuroscience [5, 6]. As our system, and VR more generally, develops greater capabilities for dynamic adaptation, we believe we can create a learning environment that optimizes the cognitive benefit for each individual student. Collecting eye-tracking data informs us of how participants attend to the material. This allows us to measure whether elements are seen and the extent to which interaction with material is aimless or guided. Coupled with system logs of which objects were manipulated and moved, we can get a quantitative sense of the user's interaction with the system. This data will also be connected to pre- and post-experience surveys of the users as well as classroom outcomes. Comparing learning outcomes provides critical information on how different strategies relate to different learning outcomes and the extent to which attention to each piece of material contributes to learning. Because this is designed as a hybrid learning experience, we will also compare results to non-VR conditions. We will have a group of students/users in the class who will not be exposed to the VR experience. That group will also be split in two, with one group having exposure to additional reading material and time to read it, while the other group will not be offered anything additional. This framework allows us to plan for testing that controls for exposure time to (any) material.

4 Conclusion

VR augmentation of traditional learning approaches in the humanities shows tremendous promise with regards to our ability to engage students, improve their long term cognitive capabilities, and measure our success in meaningful and repeatable ways. In the short term, VR enables new mechanisms for engaging students, increasing knowledge retention, and testing skills. Survey results from the first two CHE iterations have been promising on this front. They demonstrate strong student interest in VR, promising knowledge transfer immediately after VR, and indications of extended improvement in student performance following VR (in exams). Even more importantly, we regard VR as a new communication platform, one that prioritizes kinesthetic and visual learning over more traditional forms. We believe we need proven, easily scalable environments that enable many teachers and many researchers to test the possibilities in VR. While our development work at the moment is focused on the specific CHE experience, our goal is to use the lessons learned from iterating there to inform the broader design of the ECT platform. Ultimately, ECT has the potential expand the speed and the breadth of research into VR and the humanities, and help us make students, in the words of Joseph Aoun "robot proof". For this we will need a curriculum that teaches them "literacies and skills" [2] rather than content. The ECT platform is designed to do this at scale.

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