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CS6460 – EdTech
Project Proposal – Research Track

*This assignment combines the research/ideas from the first four assignments of the course.

Motivation and Context

Phenomenon to be Investigated

With virtual reality (VR) systems becoming more realistic, user friendly, readily available, and less expensive, is this the next step in Constructionism and the future of twenty-first century education? Is VR the modern-day version of Logo, a programming language developed to improve the way children think and solve problems [1], and the various robots that use it? During this research project I will explore these questions and what the future of VR looks like.

Constructionism

Constructionism was first proposed by Seymour Papert in his 1986 proposal to the National Science Foundation entitled *Constructionism: A New Opportunity for Elementary Science Education.* Papert defined it as:

> a mnemonic for two aspects of the theory of science education underlying this project. From constructivist theories of psychology we take a view of learning as a reconstruction rather than as a transmission of knowledge. Then we extend the idea of manipulative materials to the idea that learning is most effective when part of an activity the learner experiences as constructing a meaningful product [2].

Papert and co-author Idit Harel would later describe constructionism as not simply "learning-by-making", but "richer and more multifaceted, and very much deeper in its implications, than could be conveyed by any such formula." Constructionism mirrors many ideas of the constructivism, learning theory, including the idea that learning is "building knowledge structure" regardless of the situation; it emphasizes that learning occurs best when one is actively building or manipulating a physical object related to what they are learning. The educator must be actively involved throughout this process, guiding, mentoring, and encouraging the learner, not simply lecturing them [3]. While monitoring Logos experimental instruction at Muzzey Junior High School in Lexington, MA, Papert became infatuated with an art class where the students were not assigned a specific object to carve, but instead were encouraged by the teacher to be creative and carve whatever inspired them. There was no timeline for the project and as Papert watched the project develop he realized the stark contrast between this way of teaching and how math was typically taught [3]. Recognizing the benefits of how the art teacher organized and led the class, Papert wrote:

> It allowed time to think, to dream, to gaze, to get a new idea and try it and drop it or persist, time to talk, to see other people's work and their reaction to yours--not unlike

> mathematics as it is for the mathematician, but quite unlike math as it is in junior high school. I remember craving some of the students' work and learning that their art teacher and their families had first choice. I was struck by an incongruous image of the teacher in a regular math class pining to own the products of his students' work! An ambition was born: I want junior high school math class to be like that [3].

This idea of "soap-sculpture math" became a fundamental part of Papert's constructionist theory and is what makes constructionism more than just "learning-by-making." At the time of the Muzzey Junior High School project, Logos was not yet capable of being used for "soap-sculpture math". To attempt to solve the "soap-sculpture math" problem Papert began designing robots for students to interact with via Logos [1]. This experimentation and design ultimately led the invention of LEGO Mindstorm, the leading educational robotics system on the market today [4].

While LEGO Mindstorm is a great advanced towards "soap-sculpture education" VR is proving to be the next logical step. Papert said constructionism:

> adds the idea (to constructivism) that this happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity, whether it's a sand castle on the beach or a theory of the universe [3].

The LEGO Mindstorm and the previous robotics have been focused on building the sand castle because that is what the technology allowed, but with VR we are able to put students in the middle of the Milky Way or in the bottom of the ocean with Google Expedition where they can explore and study their surroundings [6]. In addition to pre-built applications, Google's VR SDK for Unity allows instructors to develop their own applications to meet their own "soap-sculpture education" needs [7].

Twenty-First Century Education

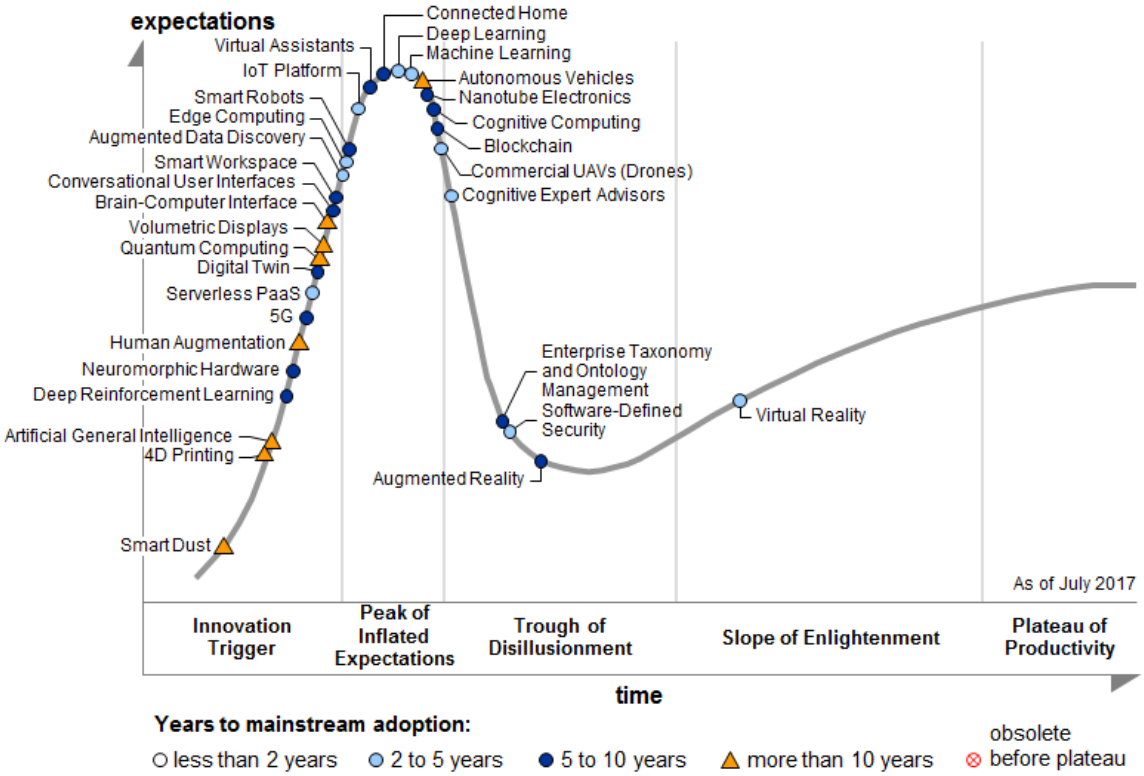
In December 2015, the UNESCO Education and Research Foresight released a working paper titled *The Futures of Learning 3: What Kind of Pedagogies for the 21st Century?*, which re-evaluated education pedagogies. The report stated that there is a need to fundamentally change the way we look at learning in the twenty-first century, that "experts recognize that the 'transmission' or lecture model is highly ineffective for teaching twenty-first century competencies and skills [5]." Seven new pedagogies are laid out as what the standard should be for the twenty-first century: renew focus on quality, foster participation, personalize and customize learning, emphasize project and problem-based learning, encourage collaboration and communication, engage and motivate learners, and cultivate creativity and innovation [5]. With this new standard, education needs to re-evaluated worldwide.

The use of VR in the classroom meets all of these pedagogies, supporting the notion that VR/AR are the future of education. Breaking each pedagogy individually, VR fit by:

- **Renewing focus on quality:** VR hardware and software are constantly being updated, developed, and released ensuring students have the highest quality education available, whether it is new topics, updated research/discoveries, or updated graphics [8].
- **Fostering participation:** By using VR in the classroom teachers and students are able to go on field trips and participate in studies/experiments that would otherwise not be possible. There is research indicating that when students are able to interact with their learning, like what is seen in *The Magic School Bus* books and television show, their interest and participation skyrockets [10].
- **Personalizing and customizing learning:** In the VR world the teacher is able to monitor the student's progress and see what he/she is struggling with. The teacher is then able to guide the student through the VR world, focusing on what the student is struggling with and modifying the world, when possible, to make the topic easier for the student to understand.
- **Emphasizing project and problem-based learning:** Before entering the VR world a teacher can assign the students a project or a problem to solve while in the world, whether it is a variation on a scavenger hunt or actually creating something while in the world. The students are then able to go off on their own and work through the project or problem while exploring the world. This gives the student direction without walking them to the answer [8,9].
- **Encouraging collaboration and communication:** In these AR worlds the students are able to work together and help teach one another. Bringing VR into the classroom is not designed to replace the current curriculum but to instead complement it. As they explore, solve problems, and create projects they can see what other students are doing, build things and share ideas to foster a better learning environment [8,9].
- **Engaging and motivating learners:** This is similar to fostering participation. If students are not engaged and motivated they will not participate in the lesson. By being dropped in the middle of what you are learning, whether it is a historical place or anatomy, VR is bringing *The Magic School Bus* to life [10].
- **Cultivating creativity and innovation:** Educators are using VR to allow students to experiment and build things in a VR/AR world, keeping them safe and allowing them to push themselves and innovate with minimal physical consequences. This is being primarily seen in the engineering, science, and safety fields, but can just as easily be used in primary school education [8,9].

Future of Virtual Reality

Each year Gartner, a world-renowned research and advising company, releases a Hype Cycles chart that characterizes the status of each emerging technology, including VR. According to the 2017 chart, the 2018 chart has not yet been published, VR is on the slope of enlightenment and trending right to towards the plateau of productivity [11]. Being on the slope of enlightenment means organizations are beginning to understand VR, see its many benefits, and are starting to implement it into everyday use. This is the first step of reaching the plateau of productivity, or when the VR is mainstream and being commonly used [12]. Continuing this rightward trend will put VR in the mainstream in the next few years, meaning we are unlocking its potential right now.



Source: Gartner (July 2017)
Figure 2: Hype Cycle for Emerging Technologies, 2017 [11]

Tasks and Schedules

I will be focusing my research on the following: a personal review of Google Expeditions and other free educational VR apps using Google Cardboard, sharing my current research with and interviewing researchers from the Lifelong Kindergarten Group at the MIT Media Lab and the Center for Connected Learning at Northwestern University, and conducting surveys with teachers and students from Arlington Science Focus School in Arlington, VA regarding their experience with VR in the classroom.

Research Methodology

During this project I will be using three research methodologies: product review, interviews, and surveys.

I will model my VR app and Google Cardboard review on hardware/software reviews conducted by *Wired, Engadget,* and other popular technology websites/magazines. I will focus on internal validity and both independent and dependent variables. By using internal validity, I will be focusing on my own opinion and assessment of the apps and Google Cardboard, giving my report a more personal touch, as opposed to simply making assumptions about what is going on in another reviewer's head. Assessing independent variables, such as cost and graphics, and dependent variables, such as ease of use and education potential, will make up the bulk of the review, giving the reader the positives and negatives of Cardboard and the apps.

For the interviews I will be reaching out to the Lifelong Kindergarten Group at the MIT Media Lab and the Center for Connected Learning at Northwestern University in order to obtain external validity for my research. My intention is to share my previous assignments with them and create an interview sheet to discuss the positives and negatives of what I have found during my research. Because both schools have researched constructionism, they will serve as a great sounding board and be able to provide strong and reliable feedback on whether I am on the right track with my research. Ideally my research would be expanded by one, if not both, organizations to expand constructionism and how we generally view education in the twenty-first century.

By sending surveys to the teachers and students of Arlington Science Focus School I will be able to gain additional external validity through the use of independent and dependent variables. The survey will focus on seven pedagogies laid out by the UNESCO Education and Research Foresight group in order to get the perspective of teachers and students alike. The survey will cover independent variables, such as, "does VR motivate students?" and "does VR encourage communication?", and dependent variables, such as, "have test scores and student understanding gone up?" By using independent and dependent variables, like the ones mentioned above, I will be able to discern if VR is meeting the pedagogies of the UNESCO Education and Research Foresight group and if VR is the future of constructionism.

Data Required

In order to complete this project, I will need to obtain the following: purchase/build a Google Cardboard; willingness to support my project and share ideas from the Lifelong Kindergarten Group at the MIT Media Lab and the Center for Connected Learning at Northwestern University, and willingness from the teachers and students at the Arlington Science Focus School to participate in the survey.

The review of Google Cardboard and free education apps will be a non-issue. There are directions online on how to build Google Cardboard and it can also be purchased from Amazon or Walmart. I will be purchasing one from Walmart because it is easy and will cost less than seven dollars. Google Expeditions is a free app and there are many resources online for the top free education VR apps for me to review.

The major issues I may run into is the Lifelong Kindergarten Group, the Center for Connected Learning, and the Arlington Science Focus School not being willing to participate in my project. The Lifelong Kindergarten Group and the Center for Connected Learning are needed to provide feedback on my research and share any research they have related to the future of constructionism. If they are unwilling to do this I will have to find another group willing to collaborate. If the teachers and students of Arlington Science Focus School are unwilling to take the survey, I will not have any data on the effectiveness of VR in the classroom. Without this data my research will be incomplete, as is the case with the Lifelong Kindergarten Group and the Center for Connected Learning, I will need to find another school willing to participate in my survey.

To mitigate the risk of the Lifelong Kindergarten Group, the Center for Connected Learning, and the Arlington Science Focus School not participating I will reach out the Georgia Tech Center for Education integrating Science, Mathematics & Computing (CEISMC) to see what support they can provide. The Center has an entire group, the Educational Research and evaluation Group, that is responsible for "creating a repository of high-quality scholarship and research in STEM education and evaluation" [13] and may be interested in my take on constructionism and twenty-first century education. One of the other major missions of the Center is to conduct outreach with the local community [14], which has brought about partnerships with the Drew Charter School and M.R. Hollis Innovation Academy. One of these schools may be using VR in their classrooms and the relationship with the Center may make it easier for the school to agree to take my surveys in support of my project.

Task List

To complete the focus items the following tasks must be completed:

1. Personal Review of Cardboard and apps
    a. Buy/build a Google Cardboard headset
    b. Research and download Google Expeditions and two other free educational VR apps
    c. Take tutorials, tours, use/experiment with apps/Cardboard. Take notes throughout
    d. Compile notes and write review
2. Share Research and Interviews
    a. Email the Lifelong Kindergarten Group, the Center for Connected Learning, and CEISMC explaining who I am and what I am researching
    b. Once a research relationship is established share current research and solicit feedback
    c. Set up time to either call or conduct an email interview with researches to get their take on VR in education
    d. Compile notes and write report
    e. Share report with participating groups
3. Survey teachers and students
    a. Email/call Arlington Science Focus School and CEISMC, explain who I am and the research that I am conducting, and ask if they would be interested in being involved in a study on the use of VR in the classroom
    b. Research other schools that use VR in the classroom and ask the above question
    c. Once relationship is established, work with point of contact on history of the use of VR in the classroom
    d. Develop two surveys, one focusing on the teachers' perspective on VR in the classroom and the other focusing on students'
    e. Verify school POC does not have any issues with the questions being asked on the survey
    f. Send survey to school with a suspense date
    g. Compile notes and write report
    h. Share report with participating school

Calendar

Week	Due Date	Assignment	Task	Notes
5	18 June	Project Proposal		
6	25 June	Weekly Status Check 1	1a, 1b, 2a, 3a, 3b	
7	2 July	Intermediate Milestone 1, Weekly Status Check 3	1c, 3c, 3d	
8	9 July	Weekly Status Check 3	2b, 2c, 3e, 3f	
9	16 July	Intermediate Milestone 2, Weekly Status Check 4	1d, 3g, 3h	
10	23 July	Weekly Status Check 5	2d, 2e, compile all research and begin outlining Project Paper and presentation	
11	30 July	Final Project, Project Paper, Project Presentation	Research future of VR	

Intermediate Milestones

Milestone 1: Research Methodology Status

For Milestone 1 I will provide the status of the research methodology for my project. I will define the variables I am using to review Cardboard and VR apps and provide a draft review based on the data I have; provide a status of my interaction and any issues with the Lifelong Kindergarten Group, the Center for Connected Learning, and CEISMC and provide a draft interview sheet; and finally I will provide a status update on my interaction with Arlington Science Focus School and CEISMC and define the variables for my survey and provide drafts of the surveys.

Milestone 2: Cardboard and VR App Review, Final Survey Data, Research Sharing Update

For Milestone 2 I will provide a complete review of Cardboard and the selected VR apps, compile the survey data and create graphs/charts depicting the results and provide analysis, and

provide and update on my research sharing with the Lifelong Kindergarten Group, the Center for Connected Learning, and/or CEISMC.

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