IMMERSION 2015

— and —

5th European Immersive Education Summit (EiED 2015)

IN PRESS PROCEEDINGS

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PRESENTATIONS

01.

Immersive Education: A View From Silicon Valley for 2015 and beyond

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Abstract:

Silicon Valley is a global center of technology advances in Immersive Technologies, including Big Data, The Internet of Things (IoT), Virtual Reality, mobile cell phone and tablet technology. How does this advancing technology relate to Immersive Education? Prof. Beaubois' presentations include brief histories of the paths of Silicon Valley technology that is today has leading role in many fields and shows how and where Silicon Valley (and Immersive Education) is heading.

Since (building) architecture is one of the biggest "things" in the Internet of Things, Architecture gives us a framework in which to base an ecosystem approach to the internet of things that includes immersive education. Professor Beaubois' presentations show examples of projects that begin to build immersive education into the very fabric of our lives as we work, play, and learn. Future projects such as The California Gold Rush Trail (building on the Santa Fe Trail project) will be discussed, as well as some of the latest advances from Silicon Valley from VR, auto, phone, buildings and wearables and how they relate to Immersive Education.

One Sentence Summary:

Prof. Beaubois' presentations involve developing an ecosystem for teaching and practice of Building Design, using VR and multiple technologies, including Big Data technologies.

Introduction

Terry Beaubois first became familiar with Virtual Reality in the early 1980's in the NASA Ames Research Center's Virtual Reality Lab, in Mountain View, California. He was a member, then director, of the Advanced Technology Application Committee (a joint committee of NASA and the American Institute of Architects). One NASA task at the time was exploring and developing VR (then called Telepresence) that would allow an astronaut (from earth or inside the spacecraft) to remotely control a robot involved in the construction, inspection or repair outside the space station. This VR effort was also related to NASA's Artificial Intelligence Lab, and the NASA Technology Transfer department. Another project in the VR and AI Labs was the development of the concepts and technology for the Mars Lander that could be controlled from earth and could have the ability to make certain decisions about terrain navigation from it's on-board video camera and computer. NASA has a very strong education program as well as needing to make presentations to Congress for funding. Our presentation of a proposal to Congress for the Mars Lander technology resulted in $40 million in funding to NASA.

At the Paris 2015 iED IMMERSION conference Prof. Beaubois will present three times, after the keynotes for these sessions:

1. Monday, Sept 7, 10:30am - noon - Age of Immersion - Panel member following keynote
2. Tuesday, Sept 8, 10:30am - noon, Forms Function and Immersion; speaker and panel session
3. Wednesday, Sept 9, 11:00am - noon (following the Teaching and Learning in the Age of Immersion keynote) Room 1

My topic "Immersive Education: A View From Silicon Valley for 2015 and beyond" will be presented during these sessions, as follows:

1. Monday, Sept. 7 - Age of Immersion session:
Following Aaron Walsh's Keynote, Prof. Beaubois will participate as a panel member, discussing "The Age of Immersion", joining Melissa Carrillo, Smithsonian Latino Center; and Caskey Dickson, Google.

Prof. Beaubois will reflect on Immersive Education Director Aaron E. Walsh's keynote, mentioning the technologies from Silicon Valley from the 1980's to new Big Data and Cognitive Computer capabilities that will be available for Education in addition to other industries and businesses. Picking up on the themes introduced in the Keynote, Professor Beaubois will discuss a path upon which Silicon Valley and Immersive Education will continue.

2. Tuesday, Sept. 8 - Inside the Forms & Functions of Immersion -
Virtual Reality: An Immersive Blast from the Past. What's the Future?
Following Caskey Dickson's Keynote, and building on this keynote, Prof. Beaubois will present for 15 minutes, discussing VR's earliest days in the 1980's NASA Labs, how VR has evolved to now include Google Cardboard, Oculus Rift, the Hololens and other forms of viewing Virtual Reality. Also, the Silicon Valley's Computer History Museum's recent presentation of some of the ongoing research of "wearable computing" in Silicon Valley, Google and at Carnegie Mellon, will be referenced.

3. Wednesday, Sept, 9 - Teaching and Learning in the Age of Immersion session.
11:30 - 12noon - Room 1
Following the Keynote by Aaron Walsh, Prof. Beaubois will speak for 30 minutes in Room 1, reviewing past Immersive Education classes as well as proposed new projects.

Terry Beaubois' experience ranges from being a consultant to the NASA VR Lab in the early 1980's, to currently being a Google Glass Explorer and Google Cardboard experimenter.

The Past:

In the late 1970's early work was being pioneered in NASA Labs in Telepresence, Artificial Intelligence, and advanced computer graphics. Some of these technologies are just emerging today.
In 2005, I used the VR program of Second Life to teach at Montana State University. The class was "Digital Collaboration for Architects" using Virtual reality and had 24 5th year Architecture students. I taught the class in a classroom as well as teaching half of the classes remotely in the Virtual World from California. My students and I learned the strengths and weaknesses of Virtual Reality's use for Immersive Education. The 24 students were on 6 four-student teams and each of the students students worked on projects of their own as well as a 4-student collaborative project.

The next year we expanded the course to Digital Collaboration for Art, Music, Film, and Architecture. The third year for the Digital Collaboration class we visited San Francisco and created a project in the South of Market area. The fourth year we studied building an Alternative Art Gallery only in the Virtual World with in world consultants from England, Ireland and Italy.

The Present:

Today, one of the most advanced VR Labs in the world is the Stanford Virtual Human Interaction Lab (VHIL) directed by Jeremy Bailenson, A brief overview of Prof. Bailenson'has work will be included in this presentation. Working with government, Facebook, Google and others the VHIL creates leading research results in the area of Virtual Reality and Education. The presentation will include references to hardware from Silicon Valley from Google Cardboard to Oculus Rift which attendees can experience during the conference. Also, the Video Camera/Computer Combination research and technology at NASA-Ames developed with the Mars Rover grant and was instrumental to the functioning of the NASA Mars rover and eventually the development of the current, self-driving car technology.

The Future:

A brief explanation and mention of the current Immersive Bent's Fort project and next year's Immersive Gold Rush Project will indicate to conference attendees what some of the continuing work of iED in 2016 in the Silicon Valley area will be. New technology originating in movie animation studios will be mentioned.

Collective Intelligence and Cognitive Computing: The Planning, Design, and Construction of buildings requires the collective knowledge / collective intelligence of the numerous Building Team members, for a building project to be successful. Current research into the application of cognitive computing in the form of the IBM Watson Program is currently underway. The application of this technology to Architecture and Education is being undertaken by Terry Beaubois. Experiments in combining cognitive computing and virtual reality will be woven in to the three presentations. With the Cognitive Computing work, the goal is not to achieve Artificial Intelligence, which is focused on robots with human-like intelligence. The goal of Cognitive Computing is to develop assistance to humans to make better, more informed decisions. Currently IBM Watson is assisting doctors in 18 emergency rooms in Santa Clara California hospitals and the lessons learned from that application with be used in our work in education and architecture. Application to other areas of education will follow.

Scope of Presentation

Prof. Beaubois will identify research throughout Silicon Valley and at Stanford University that pertains to Immersive Education on a panel an in two related presentations (one 15 minutes, one 30 minutes). The presentations will review specific applications and explore uniting the various Silicon Valley technologies applied to Immersive Education and for ecosystems for IoT for students, teachers, the general public, and professionals. Additional developments will include as the use of IBM Watson / Big Data in a Cognitive Computing system for Education.

The content for the panel and two presentations will be fit to the allowable time segments and Terry Beaubois will be available for discussions in addition to his presentations.

02.

Feature Analysis as a Simulation and Game Design and Evaluation Tool

AUTHOR(S): Eva L. Baker

AFFILIATIONS: UCLA/CRESST

ABSTRACT:

The objective of this manuscript is to describe the process of feature analysis, and illustrate its use in the design, improvement, and evaluation of learning interventions such as computer games and immersive simulations. We have undertaken a qualitative analysis of features to determine those that should be included in a technology implementation or assessment to support effectiveness or validity inferences. The features have been drawn from ontologies of content standards and cognitive demands. We applied this feature analysis to a game whose objective was to teach middle school physics to third grade children. The administration of the game children resulted in student learning as indicated by a moderate effect size. We have also tested this approach in the U.S. statewide testing program. The results indicated that our features predicted 50-60% of the variability in item difficulty. The manuscript will conclude with a discussion of the use of feature analysis used either as specifications or in post hoc analyses of instruction or assessment in games and simulations.

ONE SENTENCE SUMMARY:

We will describe the process of feature analysis, and illustrate its use in the design, improvement, and evaluation of learning interventions such as computer games and immersive simulations.

Introduction

The objective of this presentation is to describe the process of feature analysis [1, 2], and illustrate its use in the design, improvement, and evaluation of learning interventions, such as computer games and immersive simulations. The larger purpose of this work is to create a set of validated features for use by developers and assessment designers. In our studies of technology-development and evaluation, we have undertaken the qualitative analysis of features to determine those that should be included in a technology implementation or assessment to support effectiveness or validity inferences [3-5]. The features have been drawn from ontologies of content standards and cognitive demands [6]. These features can be tagged in databases so to inform their contribution to learning, both in terms of variance accounted for and their relationship to types and level of learning achieved.

Scope of Work

Although applied in many of our studies, the design of physics games for children is the current case. The goals for the game were selected from the United States' Next Generation Science Standards in physics. An ontology of sub-ideas was developed related to the conceptual understanding of physics content, e.g., friction. In addition, a problem-solving ontology was also used as a source of design features for the game and for its assessment.

Results

Task features, involving numbers of scenarios, stimulus properties (how many concepts per frame and range of response modes) were developed. Together these were used to guide the development of game levels and to assure that outcome measures represented the range and difficulty of content, problem solving, and tasks expected to be learned, moderated by the game mechanic in use. In the development of game outcome measures, the use of features also allowed the rapid development of performance assessments that met content validity requirements implied in the standards and in game specifications.

Conclusions

The administration of the game resulted in student learning as indicated by a moderate effect size. This feature analysis approach was intended to assure the validity of instructional design and assessments. The approach is being generalized by us across different environments. For example, we tested the program in a U.S. state assessment over on a three-year period and involving four grade levels in both mathematics and English language arts. The results indicated that associated features of content, cognition and task accounted for between 50% and 60% of the variance of item difficulty. The manuscript will conclude with a discussion of the use of feature analysis used either as specifications or in post hoc analyses of instruction or assessment.

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ACKNOWLEDGEMENTS:

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03.

Combining Low and High Tech to Enhance the Learning Experience and Engagement of Undergraduate Non-major Art History Students

Authors: Amir Bar*, Jessica Locheed

Affiliations: The University of Houston

Summary: This presentation will introduce an innovative approach to teaching Art History featuring an analysis of a work of art guided by mobile technology as well as a printed deck of cards. We will present this new approach to design and delivery of instruction as well as the data resulting from its use with undergraduate students (250 students in two separate classes) at the University of Houston.

Abstract: Today's technology is more advanced than ever. We can do things today that we could only dream of a few years ago. With the new technologies available to us in pedagogy, the challenge is to find ways to make the best use of these technologies and develop best practices. The proposed presentation will show a real life solution/approach developed to enhance the learning of non-major Art History students at the University of Houston.

The Menil Collection Mobile Assignment was developed to allow undergraduate students to engage with the art in the renowned Menil Collection in Houston by taking advantage of mobile technology (having students use their own mobile devices) and by using a more traditional learning strategy of providing tangible printed information cards.

In the assignment, students were guided to visit the Menil Collection and were given a set of 11 cards. Each full-color printed card provided information on one aspect of an artwork's design such as line, shape, light, color, texture, etc. The cards provided explanations of the terms and several examples. Students could review the cards prior to the assignment without using any technology.

Once the students arrived at the museum, they scanned a QR code that was placed on one of their cards. The QR code directed them to the mobile assignment. In the assignment, students were asked to choose three different works of art (choosing anything they liked) and to analyze the art based on two out of the 11 cards, choosing the design aspects that affected them most. After the students entered the name of the artwork and the cards they were interested in, the mobile app directed them to the right questions. They answered the questions in front of the artwork using their mobile device.

The assignment results showed several significant details. When this mobile assignment was used during the Spring 2015 semester in a class with 185 students, 75 different artworks and 554 combinations of cards were chosen. Almost every submission from a student was unique because students were allowed to choose the artwork and design aspects they liked the most. This has a

significant pedagogical importance because it increases student engagement through choice of topic and choice of mobile device (phone, tablet, laptop).

When students were asked if they would recommend this assignment to other students, 92% said they would.

The presentation of this project will include a live demo/ or screen captured video of the product (mobile and cards). The presentation will also include the design approach and will show some of the feedback from the students. We will develop the idea that this approach can be applied to many other fields of education.

References and Notes:

Link to the live demo: *view in browser*
Media 1: Slide #1
Media 1: Slide #2
Media 1: Slide #3
Media 1: Slide #4
Media 1: Slide #5
Media 1: Slide #6
Media 1: Slide #7
Media 1: Slide #8
Media 1: Slide #9
Media 1: Slide #10

04.

Title: Methods of enhancing the role of education through use of VR as developed and applied by EON Reality

Authors: Y. Froger[1], M. Dautricourt[1]

Affiliations: [1]EON Reality S.A.S - France Hub

Abstract: Interactive 3D solutions have shown to increase students' attention levels by 92% and increase test scores by 35% – while at the same time creating a new level of engagement for students and staff. EON Reality's Virtual 3D Learning solutions are transforming education by bringing interactive 3D technologies to classrooms of all levels. Our customers include Carnegie Mellon University (US), Imperial College (UK), Nanyang Technological University (Singapore) and hundreds of academic institutions worldwide.
We have solutions that address two fundamental sides of the educational experience on one hand helping teachers and educators tailor their teaching material by creating exciting 3D real time content and easily developing a full lesson content, on the other providing a VR common space where the teaching experience can be shared.
Create: teachers can develop complete, blended learning environments with EON Creator, an interactive tool that allows for combining 3D content with videos, sound effects, annotations, Wikipedia, PowerPoint, YouTube, and more.
Explore: teachers and students can upload their work to the EON Experience portal, an interactive online library that is home to thousands of 3D objects, avatars, scenes, and applications.
Collaborate: students and teachers can meet virtually via EON Coliseum, a multi-user 3D environment that makes collaboration possible, anytime and anywhere.
We are extending these capabilities into the field of mobile devices, thus creating a tool to allow the effective access of all to more compelling and efficient ways of learning.

We firmly believe that knowledge is a human right.

One Sentence Summary: Using virtual reality and augmented reality to improve education and training.

Main Text:

Introduction

Based on fifteen years of R&D, EON Reality is the world's leader in virtual and augmented reality for knowledge transfer in industry, education and edutainment. We provide virtual reality and digital media solutions that improve communication and knowledge transfer. From simulation based learning and safety training, to the creation of interactive 3D sales and marketing materials, we make edutainment applications that provide realistic experiences anytime, anywhere.

Our solutions in the education area allow us to overcome some of the main difficulties we are now facing in the education field: the first issue is the growing need in terms of education with the decreasing global budget available and the second is the overwhelming quantity of knowledge coming with new technologies.

The first issue mentioned has several causes which we investigate and take into account in our research and development process. The first one is the increasing demography. Emerging countries with growing population require a better access to knowledge, in terms of education at school but also for their developing industries that have to develop their employees' skills. Secondly, our population is aging, this bringing new needs, especially in the medical area. This calls for the increase of medical specialists.

Our EyeSim application was created in this context (Figure 1). This application allows ophthalmologist students to learn faster ocular anatomy and physiology, and subsequently diagnostic procedure, it is in used at Loyola University in Chicago. The project can be considered as a potential answer to the significant shortfall of ophthalmologists in developing countries and the widening gap between need and supply.

Another reason for the occurrence of this issue is that companies are now favoring training for their employees. A study made by Arie De Geus of Shell in 2002 had shown that the key element to a company's long lifespan is its ability to learn fast, explaining why companies are progressively encouraging training throughout lifetime.

In developed countries or emerging ones, in education institutions or companies, the decrease of financial resources allocated to knowledge is taking its toll. Improving the efficiency of knowledge transfer is one of the most important challenges nowadays due to the aspects referred to above. This is where our expertise in virtual reality comes in.

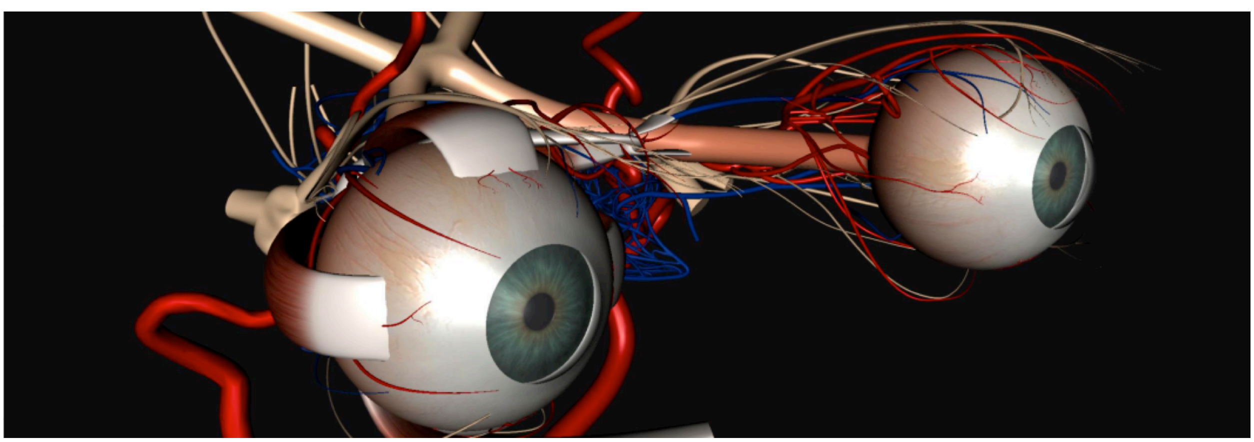

Figure 1. Highly detailed models of the eye and ocular structures in EyeSim application.

The second challenge is to face the increasing volume of information coming with the spread of the Internet. We are submerged by information and this makes it difficult to filter accurate, relevant and reliable sources.

Tools which give access to knowledge, such as Google Search engine can be complicated to use for the uninitiated, despite Google having developed its algorithm to make searches easier and more intuitive. Obtaining precise and reliable answers using this tool requires some research tactics which for some takes long to assimilate. Moreover, the algorithms to reference websites favour certain pools of data over others. EON Reality's goal is to make knowledge clearer and easier to identify and transfer.

Advantages of the emergent technologies in learning

With these concerns in mind, we have put resources and skills into our research and development and made it very apparent that using virtual reality learning environment (VRLE) has many benefits. Firstly, it allows people to learn faster. Indeed, being immersed in a virtual environment and interacting with it makes people more involved in their learning; this is a motivating way to learn [1]. Secondly, VRLE helps memorizing information, people learn faster. A project conducted for Atlas Copco (a Swedish company which manufactures industrial tools and equipment) to train their Oil Rig operators in a simulator shows an acceleration of more than the double in learning time.

Another benefit of VR is the possibility to offer less expensive solutions for education. Emergence of technologies like the Internet, mobile devices and their ease of access makes knowledge more accessible to all nowadays. Companies such as Facebook and Sony are investing a lot in Virtual Reality. All these factors lead to a decrease in cost for knowledge access. Head-mounted display devices can now be found for under 600 $, compared to five years ago when the minimum cost would have been around 2,000 $. Virtual Reality (VR) and Augmented Reality (AR) have never been so financially accessible and this facilitates the circulation of knowledge.

An approach to improve learning

Current technologies offer access to an overwhelming volume of information. Our aim is to find a way to present information in a more comprehensible and clearer way; but it should not be at the cost of completeness and quality. In EON Reality, we favor small blocks of specific knowledge that are easier to memorize and allow for accurate learning. We have created EON Experience VR, a large VR/AR library of small applications which focus on specific educational subjects.

Moreover, information has to be adapted to the purpose. We distinguish two different ways of learning: education and training. Education involves the assimilation of a wider set of assets tightly linked to culture as well as global aspects. Training is the process of learning new skills. For this purpose, VR is an ideal solution. Simulation in immersive VR systems helps trainees to gain insight into the real conditions under which the tasks they are preparing for will be happening. It facilitates the learning of good reflexes. In some cases, live or on-site training is very expensive or infeasible, as is the case for the oil industry or medical surgery. For example, the oil company ExxonMobil use a training operator simulator made by EON Reality (Figure 2). This simulator is designed for training process operators and engineers in oil and gas production, processing and transportation facilities. With this simulator, ExxonMobil can offer training in a safe and controlled environment.

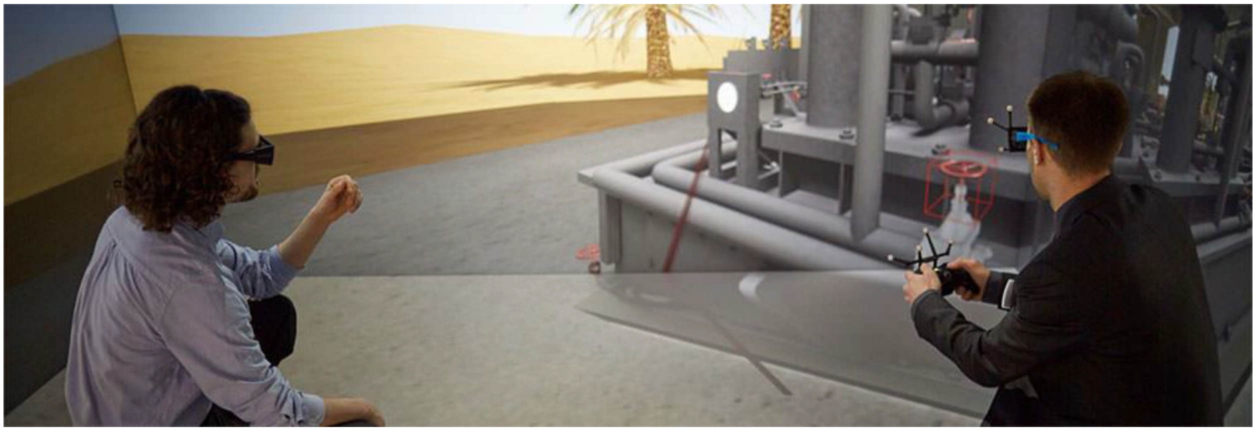

Figure 2. Immersive 3D Operator Training Simulator designed by EON Reality for ExxonMobil

Optimizing the transfer of information is also a crucial aspect of learning. We aim to use innovative and varied approaches of delivering knowledge. Teachers and learners do not have the same needs but the information is the same. For this reason we designed different software able to use the same information with different means. With the use of EON Creator, teachers can develop, in an intuitive way, their own learning environments and combine 3D content with videos, sound effects, annotations, add Youtube and Wikipedia links and more. Through the EON Experience Portal, they can upload their work in an interactive online library, allowing students to access and make further use of it.

EON Coliseum is a piece of software which enables people to work in a collaborative way. Studies have shown that collaborative learning has a beneficial impact on memorization, be it through cooperating or competing within the given learning tasks [2]. And to go further in this idea of collaboration, we are currently working on sharing VR learning experience via social networks.

Conclusion

The main goal of EON Reality is to spread knowledge. We are creating VR/AR solutions that are affordable and available. Our 3D interactive content paired with VR systems makes learning a faster process and a more enjoyable one.

By adapting the information to the intended public, knowledge is clearer and more accessible.

Use of VR learning is predicted to increase in the coming years. Education is now a promising economy. In 2013, the educational global market was estimated at 3200 billion euros, outgrowing thus the oil market. This year the training market has increased by 15 %, the main reason being the fast economic and technological changes. Training has become the highest priority for human resources management.

For this year, the market for AR and VR is estimated to be of around 4 billion dollars, however, the market advisor Digi-Capital predicts a growing to 150 billion dollars by 2020 [3]. Those data confirming the development of VR in the education area.

We firmly believe that knowledge is a human right and that all the efforts we put to make it efficient and affordable will lead future generations to a better education.

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05.

Engaged Pedagogies Through Virtual Worlds

Authors: Abarca, Merdith E., Hill, Janet L., Weller, Jalaine

Abstract: Scholar and English professor bell hooks states that the values of an "engaged pedagogy" reflect a "progressive and holistic education" that emphasizes "well-being as a process of self-actualization" for students and teachers by connecting the "will to know with the will to become." Furthermore, an "engaged pedagogy" is one that also allows students the freedom "to assume responsibility for their choices" (*Teaching to Transgress*, 1994: 15-19).

This pedagogy that is rooted in being and becoming was central to the teaching of my most recent literature graduate course that focused on Literature of the Americas. This particular course sought to upset—in a positive, constructive, and exploratory manner—the traditional graduate literature course model. Questions rooted in emerging technologies, digital rhetoric, and the digital humanities motivated the focus of this reinvigorated course, such as: How can immersive technologies such as Virtual Worlds enhance the critical, collaborative, and creative outcomes of a literature course? How do digital rhetorics in the context of a literature course expand and shape what is generally understood by Digital Humanities? How do immersive technologies redefine the practices of an "engaged pedagogy" for the 21st century digital citizenship?

In our presentation, we will address the process of designing and integrating a Virtual World creation as the culminating research project for this graduate course. The introduction to the online Virtual World *Second Life* took place in this course by the class's participation in the Smithsonian Latino/a Virtual Museum's Day of the Dead event. Students created a virtual altar dedicated to Afro-Latinas as Community Builders. From this project, students then expanded their emerging skills by creating props to develop the course's final project.

The purpose of three presenters is to provide the unique perspectives of the professor, instructional technologist, and student, as well as their thoughts on this educationally innovative and creative project. Ultimately, this project developed into the creation of an "Afro-Latino Foodways Virtual Museum" in which each student researched, created, and curated an exhibit. The museum engages a period of over four hundred years of history and covers different geographical areas of Latin America and the Caribbean. In our collective presentation, we intend to share the journeys we traveled via technological pathways in pursuit of enhancing critical thinking abilities, encouraging creative prowess, and cultivating communities of solidarity that go beyond the traditional structure of a face-to-face classroom.

One Sentence Summary: Immersive Technologies enhancing literature courses through digital rhetorics.

Main Text:

(A) Media 1 Afro-Latino Foodways Museum Video (enclosed – youtube link available)

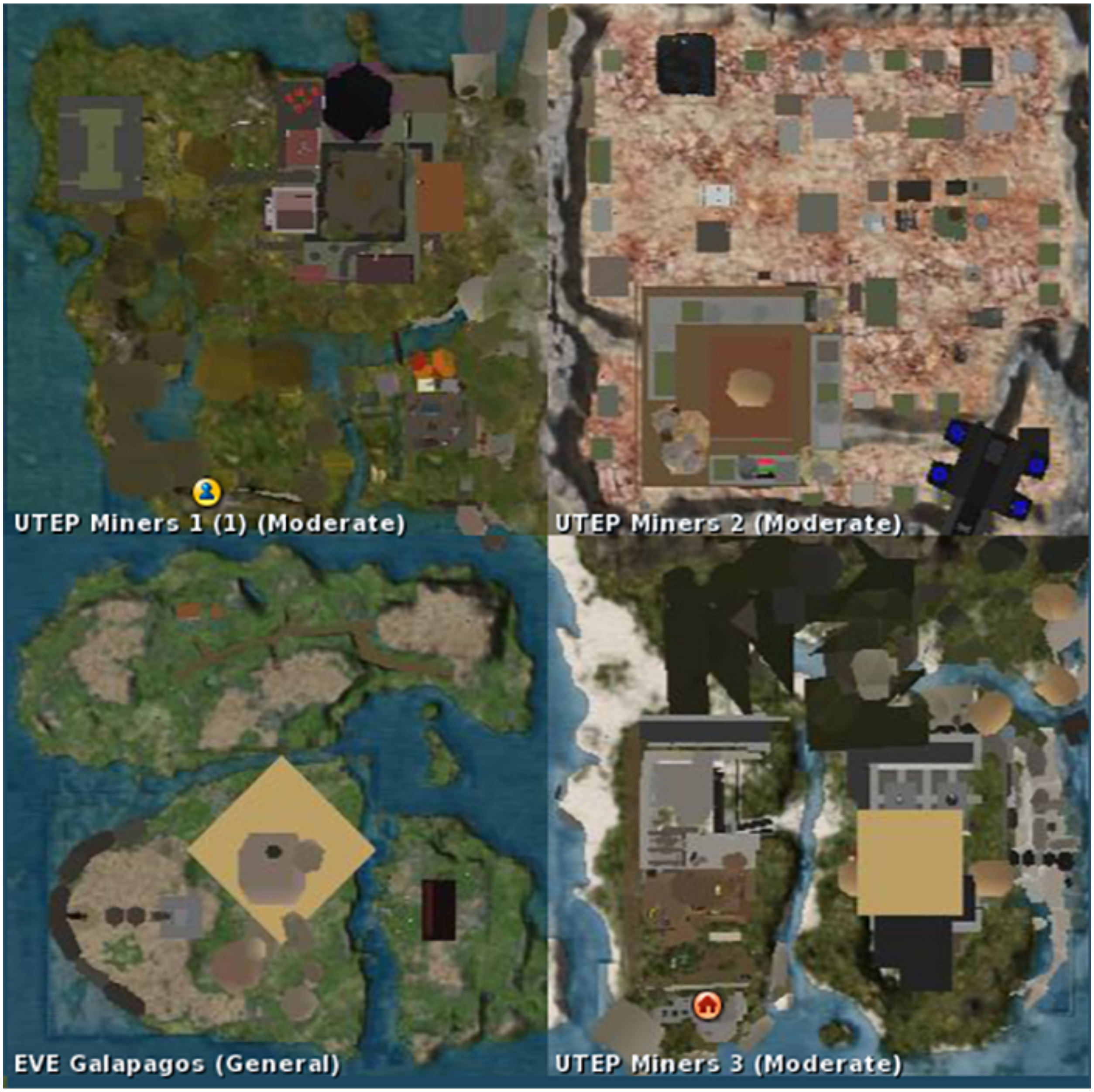
Much of the current discourse in education is exploring ways to develop the best pedagogy for teaching the twenty-first-century student. One mode that has become an increasingly common approach is that of the flipped-classroom in which the focus is to shift from an instructor-centered to a student-centered classroom in which technology is central, whether it be via online teaching, virtual worlds, or various other means. The center of this discussion generally focuses on students. We argue, however, that effective learning takes place only in a community that encourages critical, reflective, and collaborative dialogue between its members: instructors, students, and, ideally, beyond. Making the classroom a place for critical dialectical exchange is key to English professor bell hook's "engaged pedagogy."[1]hook's model sees education as "progressive and holistic." [2] This engaged pedagogy connects "the will to know with the will to become" which leads to "a process of self-actualization"[3] for both students and instructors—not merely one or the other. An "engaged pedagogy" also allow students to assume responsibility for the process of learning inside and outside the physical classroom experience.

(B) Figure 1 Students from the Afro-Latino/a Voices course.

My, Meredith's, food-centered pedagogy follows these guidelines. The combination of hook's "engaged pedagogy" and my scholarly interest in exploring the power that food holds in shaping, recording, and transmitting our humanity has guided my approach to teaching literary and cultural studies courses for the last 15 years. A commitment to this teaching and learning paradigm and my passion for food studies come together in this particular collaborative presentation. Together we, the professor, instructional technologist, and graduate student, will describe how a graduate literature course cohort at the University of Texas at El Paso (UTEP) engaged food studies through an engagement with immersive education technology in the form of a virtual world learning community.

(C) **Figure 2** Piri Piri, a painting by Rolando Brisenios greets visitors on Miner Island 1.

The Academic Technologies (AT) department at our university approaches learning with a like-minded method of engagement. Educator William Robertson (a.k.a. Dr. Skateboard) suggests that the most effective learning comes from places of ambiguity and high risk, and this informs AT's and, subsequently, our course's immersive learning experience. Here, Robertson is referring to his tactic of using skateboarding to teach physics, but the same idea is applicable when introducing emerging technologies into the college classroom. In our case the collaboration linked AT with an American Literature graduate course by integrating the virtual world of Second Life into the course's food-centered pedagogy. The specific focus of this class was "Afro-Latina/o Voices: History, Food, and Memory" and, as a team, we—instructor, students, and AT—created as the end product of the course an "Afro-Latino Foodways Virtual Museum."



(D) **Figure 3** UTEP's Islands in Second Life from above)

This collaboration began in response to the UTEP Academic Technology department's mission to work with instructors to research and integrate technology into teaching and learning. Through AT, UTEP owns four *Second Life* Islands, which house various 3D learning interactions used to supplement courses throughout the University. AT's central philosophy regarding virtual worlds (and any technology integrated into teaching and learning) is to use technology as a tool that *enhances* the learning experience in the course. AT's learning environment capabilities range from a simulation of a Mexican Colonia populated with bots that allows health science students to practice research skills, to a construction site that gives engineering students the opportunity to inspect dangerous situations without the risk of getting hurt. In the case of the "Afro-Latino Foodways Virtual Museum," students in a humanities course were able to participate in a project-based learning where the field of digital rhetoric merged with virtual technologies. As evidenced by these classes, virtual worlds provide a rich immersive experience for students to think digitally about communicating visually, textually, and audibly; while in the process they become producers of technology not just consumers/visitors of it.

D **Figure 4)** Construction Safety Simulation.

(E) Figure 5 An Empty Space. Imagine the Possibilities!

The goals for the Literature of the Americas course we are discussing were to explore aspects of the evolving digital humanities from a pedagogical, rather than an archival, perspective to accomplish the following: (a) explore the use of digital rhetorics to communicate stories, histories, and ideas to move beyond a traditional literary research paper; (b) share knowledge beyond the boundaries of a classroom by creating communities of dynamic learners; and (c) use technology to explore what a "progressive and holistic education" that links "the will to know and will to become" means within the social and cultural structures of the digital age. Our presentation will discuss how we have begun to respond to and fulfill such goals.

(F) Figure 6 The Smithsonian LVM and UTEP Day of the Dead Branding)

The history of collaboration that led to creating a virtual museum based on Afro-Latino foodways began in 2011 when the Smithsonian Latino Center (SLC) approached AT with a request: to house pieces of their virtual "Day of the Dead Museum," a 3D celebration, on UTEP's Second Life Islands. After UTEP agreed, AT sought instructors who were interested in using and contributing to the creative content in this museum. It was the "Day of the Dead" celebration that first introduced Virtual Worlds to my, Meredith's, teaching. For a 2013 Mexican-American Folklore course, students, who had never heard of Second Life, were assigned to create an altar and an avatar that signified for them the meaning of the "Day of the Dead."

(G) Figure 7 Mexican-American Folklore altar at the Smithsonian Latino Virtual Museum, 2013.

The avatar assignment became the impetus for Smithsonian Latino Center's annual workshop on exploring cultural identity through avatars. This course requirement also led one student in this course to win the Smithsonian Latino Virtual Museum's "Fiesta de las Calaveras Costume Avatar" award for her elaborate avatar representing an aspect of her familial history as well as her cultural heritage. The success of this transmedia-based course activity revealed the possibilities of using virtual worlds to educate the twenty-first century student in a digitally-driven twenty-first social and cultural environment.

(H) Media 2 – Short Excerpt from Altar de Muertos (for now the Youtube link is here- will include the video in our ppt presentation: https://youtu.be/KoYpes0WztQ?t=168)

Virtual Worlds help reimagine and stimulate a redefinition of what a graduate literature course could be by shifting the traditional model of reading, discussing, and writing. Immersive technologies push students outside their comfort zone by expecting them to use their literary skills to transform literary critical interpretations into creative/artistic virtual realities.

(I) **Figure 8** Students attend a workshop on Virtual Environments conducted in Second Life by the team at the Smithsonian Latino Museum.

The virtual museum, as a collaborative project, further moved students from the comfort of doing individual written research papers that address disciplinary concerns often only of interests to literary scholars. Students created a final well-researched class product that speaks to global audience. The remarkable aspect of the end result was that students and faculty were working with technologies new to them,; therefore, pursuit of this purpose required teamwork among the instructor, the students, and the AT experts.

(J) **Figure 9** Teamwork: Instructor, Instructional Technologist, and Associate Director of Creative Studios at Academic Technologies at the grand opening of the Aftro-Latino Foodways Museum.

The collaboration that took place to complete the virtual museum created a solidary among students and an intellectual/technical liaison between the course's instructor and AT's instructional technologist. We see this form of collaboration as reflecting a model to speak of twenty-first century learning environments as contact zones of digital communities.

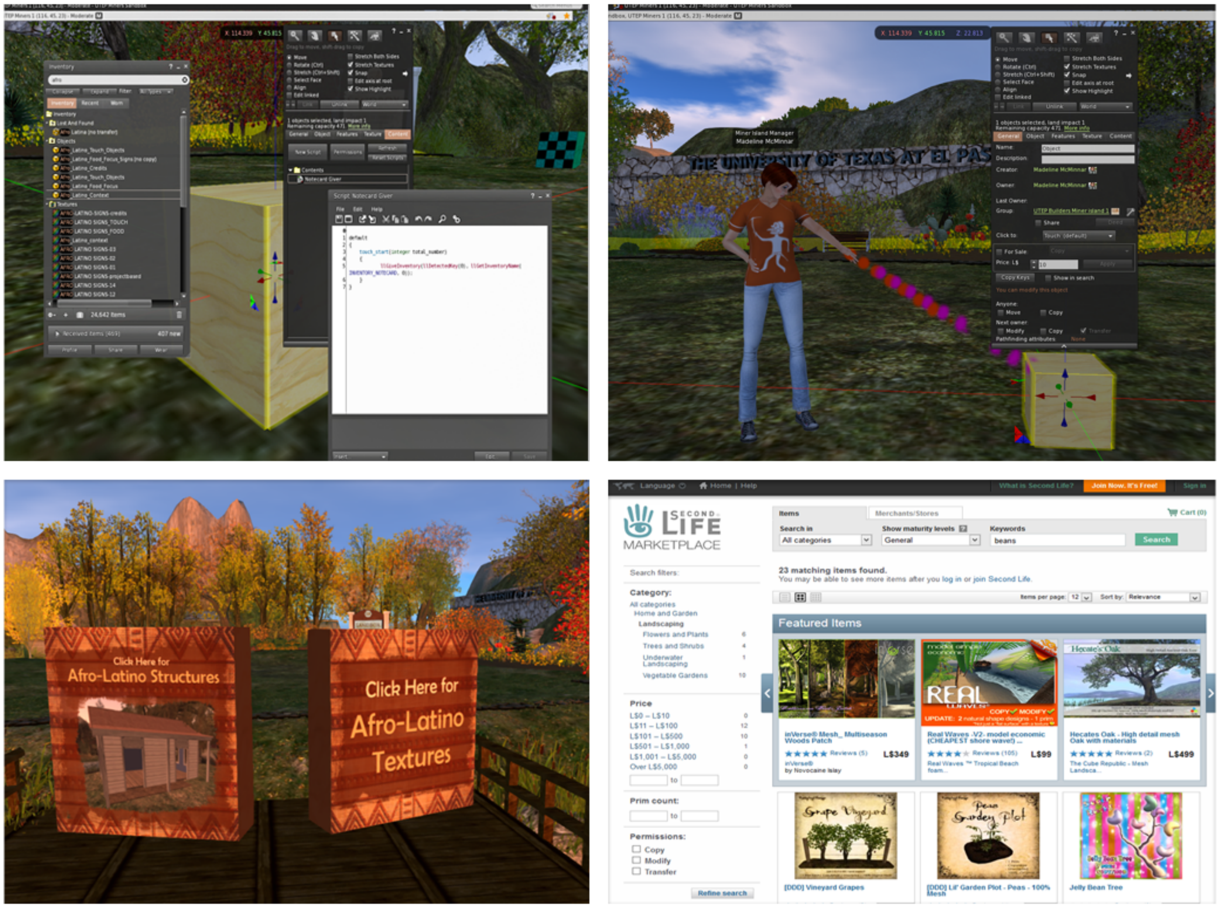
Digital communities, as with any other kind of collaboration brings forward challenges unique to the group and the individual. The challenge for me, Janet, as the Instructional Technologist, was not only to help the professor and students work with the technology, but also to help them understand the creative process that occurs when designing and developing games, multimedia, and 3D artifacts. I had to consider how students might take textual narratives and turn them into visual representations and how we might design an environment that invites users to then interact with those representations.

(K) Figure 9 Clearing out the existing building in the space allowed everyone to think outside the four walls of a traditional museum, then allowed us to block out pathways and ideas.

These sorts of considerations pushed the students, the instructor, and me collectively to think outside the four walls of a traditional museum and conceptualize something that uses the assets of a virtual world to a fuller extent. As a team, we created a virtual "living" village representing 400 years of Afro-Latina/os' lives expressed through culture and foods. Since we were aware that without prior *Second Life* experience students faced a steep learning curve, both the AT team and class professor confronted the challenge of determining which aspects of *Second Life* students most needed to be adept in for this particular project.

(L) **Figure 10** Afro Latina Community Builders Altar: The altar was the student's first project, allowing them to practice their new skills on a small scale project before building the museum.

Ultimately, we, Meredith and Janet, focused on skills such as using simple prim shapes with textures and scripts to represent various artifacts and also introduced students to the process of shopping in the *Second Life* Market and then modifying purchased items. This allowed students to focus less on the intricate task of building on a larger scale and more on thinking about visual rhetoric and digital writing. Throughout the process, equipping students as best as possible—by providing support, conducting workshops, and maintaining an open-door policy for one-on-one assistance—remained of the utmost importance.



(M) Figure 11 Second Life Skills – building using prims, texturing, simple scripting, creating notecards, and even shopping, were taught to students during several workshops.

Accomplishing this immersive learning agenda pushed students into an active dialogue and collaboration that transcended the average boundaries of the graduate classroom in which students typically interact academically within the classroom but rarely outside of it.

(N) **Figure 12** Black Eyed Pea Exhibit by Jalaine Weller.

The creation of a virtual community required the creation of a physical community, for in order to imagine and construct the virtual activities of the course students, such as Jalaine, chose to meet as groups in one another's homes for "Second Life parties" where they would discuss, create, and, perhaps most importantly, help one another build the digital exhibits from the ground up. In addition, students often met one-on-one with the professor and/or instructional technologist for feedback, assistance, and even collaboration. Thus, the process proved to be a true digital partnership: among the students, alongside the professor, and with the invaluable support of the Academic Technologies department. Each unit helped the others and, thereby, we formed a tight-knit community as we digitally created, constructed, and narrated a cultural and literary history of Afro-Latina/os.

This brings us back to our central question: Why incorporate Virtual Worlds in a Humanities class?

(O) Figure 13 Completed village, from above.

As a twenty-first-century community of learners, instructors and students must consider their digital citizenship in a world that undeniably exists on both a physical/material plane and a digital plane. Subsequently, I believe it is imperative that contemporary education seeks to equip them with the ability to engage critically both physical and digital rhetorics, to understand the importance of digital civility, and to pursue the construction of digital communities of solidarity. Virtual worlds, such as *Second Life*, help us (re)conceptualize the importance of digital humanities from an archival process to the best pedagogical practices that addresses digital rhetoric, digital communities, and digital dialectics, or the reality of the twenty-first century learner. Virtual Worlds technologies provide opportunities for courses in the Humanities, such as literature, to digitally create ways so that the stories of those read about in books gain a 3D virtual reality accessible to a global community.

(P) Figure 14 The marketplace: the hub of our village

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06.

Disruptive Enabling Technologies and Immersive Education

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Abstract:
Disruptive enabling technologies in the form of wearable sensors and ambient intelligent interface devices are set to totally transform immersive education practices. This presentation focuses on the latest developments in wearable lifestyle sensor technologies such as Neurosky's consumer brainwave and body sensing devices to describe how measuring and visualising physical and mental states can be used to deliver quantum changes in education practices. These devices and their associated applications that provide real time analysis of attention and emotional states provide new opportunities to provide more personalised and adaptive education experiences.

One Sentence Summary:
Wearable Sensors and Data Visualisation Technologies are creating new opportunities for personalized Immersive Education

Main Text:

Introduction and Background

The concept of "immersion" in any activity is widely accepted as fundamentally important for learning and developing. The immersive nature of games is one of the main reasons for their popularity. Games provide a "flow" of conscious engagement in which players voluntarily invest their time, attention and money to participate in activities which provide the physical and mental challenges that form the basis of our development.

Over the past two decades, developments in video game technologies from arcade games to highly realistic blockbuster console games have led to the concept of "serious games and simulations" being increasingly widely accepted as an important media for corporate learning and development. "Americas Army" was one of the first examples of the serious games genre and was originally developed as a recruiting tool to stimulate young people's desire to consider the Military as a career option through the use of role playing games. Whilst it was regarded as a big success in generating new recruit applications, it was also realized that these games had potential for training recruits by immersing them in storylines and environments which allowed them to develop the skills needed in real world situations with exposing the recruits to danger and also reducing the cost of training.

The immersive nature and realism of these virtual world environments and storylines that players could relate to were important factors in not only engaging players but also in the effectiveness of the learning outcomes. The "Immersion" factor in these games is related to the extent to which players are attracted to the scenarios and storylines and the nature of the challenges presented. All of this, it is argued in this paper, has led to a concentration on making the sensory experience as rich as possible rather than developing an understanding of the basic games psychologies and mechanics that underlie the use immersion for education practices. This paper seeks to introduce the concept of gamification and disruptive technologies as a potentially more effective and targeted approach to Immersive Education.

Case Study on Gamification and Wearable Technologies for Personal Health Education

This paper explores the impact of disruptive technologies such as the internet of things, big data and wearable technologies on immersive education and is based on a personal case study carried out over the last 2 years by the author who has explored the potential of these technologies to improve his personal health management.

Figure 1. Impact of Case Study on the Author's Appearance

Figure 1. illustrates the impact of the project on the author's change in appearance over the two years of the project. The majority of the weight loss (21Kg) was achieved within 3 months of starting the project in June 2013.

Health Education is a very good example of the importance of Immersion and can illustrate the difference between Immersive Education for the acquisition of Knowledge and Immersive Education to influence behaviours, understanding and actions.

At the start of this project, the author was obese and in a pre-diabetic condition but these circumstances, although lifestyle related, did not present any serious medical problems or impact on the author's daily life. As a consequence, although aware of his obesity, the author was not motivated to make any changes to his lifestyle or undertake education activities to improve his knowledge or understanding of the potential long term consequences of his condition.

Without motivation for change or incentives to better understand and adopt best lifestyle practices, the author was not engaged in developing personal healthcare management skills or practices and would have been reliant on corrective medical interventions instead of preventative interventions. The author would not have been immersed in the personal health education initiatives available and increasingly promoted today because, although health knowledge was of interest, it made no impact on the author's daily life. The author was effectively a "spectator" of his own health rather than an engaged practitioner.

It was combination of circumstances in June 2013 which led the author to explore the potential of gamification and wearable technologies for personal health management. The primary factors for triggering this activity were the discovery from a DNA analysis that the author has a 32% probability of contracting Diabetes 2 and reading an article on the BBC website about wearable technologies.

Measurement and Feedback

The case study involved wearing a fitness tracking bracelet which measures physical activity and sleep, collects the data and displays the results within a free mobile application.

Figure 2. Example Wearable Fitness devices used by the Author

Figure 2 shows two of the devices used by the author during the case study. One of the devices, the Jawbone UP device provided a smartphone application which not only shows trends in physical activity and sleep patterns but also provides tools to calculate calorie consumption and nutrition based on food and drink consumed. This requires the user to enter the food and drink manually and, in some cases, to enter the nutrition data found on the food packaging.

The key factors for education and immersion in this project are automatic measurement and feedback, coupled with good data visualization that assists understanding. The fact that the data is personal and is displayed on demand in a format which helps the user to understand the impact of their actions leads to immersive learning linked to behavioural change and putting into practice the lesson learnt.

Immersion in the process of self-directed learning informed by automatic data collection and analysis provided for better understanding of health management and, more importantly, practical implementation of changes in lifestyle.

Conclusions - Immersion and Personalised, Self-Directed Education

Immersion in any activity by focusing attention and limiting distractions helps to facilitate absorption of knowledge. Immersion can be influenced by motivating factors. These motivating factors can either be extrinsic or intrinsic or a combination of both.

Extrinsic motivation can be provided by potential rewards e.g. money, qualifications, penalties for failure whereas intrinsic motivation comes from the pleasure and satisfaction of the activity. Games generally provide intrinsic motivation and more sustainable outcomes whereas extrinsic motivation in education can support the acquisition of knowledge, it is less likely to be sustainable and have an impact on behaviours and understanding.

The main conclusion drawn from this case study exercise is that disruptive technologies which provide ambient and automatic personalized performance measurement and feedback coupled with good data visualization and "Smart" coaching not only creates a far more immersive experience but also goes beyond the acquisition of knowledge into greater levels of understanding and behavioural change.

The use of wearable devices and Gamification strategies today is exemplified in the European projects PEGASO (http://www.pegaso4f4.eu/) and DOREMI (http://www.doremi-fp7.eu/) where Italian Serious Games specialists, Imaginary have developed applications which use games combined with technology to capture lifestyle data and physical activity to personalize games which immerse the users into activities designed to enhance their physical and cognitive wellbeing of the users which range from teenagers (PEGASO) to the elderly (DOREMI).

07. N/A

08.

Measurement of Domain-Specific Creative Thinking in an Immersive Team Training Simulation

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ABSTRACT:

Creative thinking is required in both organizations and people. The current military and industrial operating environment has become extremely complex. For example, in some cases there are complex, unpredictable, and undefined tasks, and there is no acceptable solution that one has been trained for. Thus one must invent or create a solution (creative thinking) and monitor its progress. Creative thinking was long considered domain-general, e.g., Torrance Test of Creative Thinking. We found some support for the impact of the simulation on creative thinking. However, the effect sizes were very small. Our current creative thinking research is building on our prior work in the Multi-Mission Team Trainer and new measures have been designed to assess domain-specific creative thinking in a team trainer immersive maintenance simulation.

ONE SENTENCE SUMMARY:

We found some support using domain-independent creative thinking measures for the impact of the simulation on creative thinking.

MAIN TEXT:

Introduction

Creative thinking is required in both organizations and people. The current military and industrial operating environment has become extremely complex [1]. For example, in some cases there are complex, unpredictable, and undefined tasks, and there is no acceptable solution that one has been trained for. Further some trained solutions will lead to disastrous results. For situations where one has not been trained or there is no Navy doctrine or one performs duties outside of one's job, one must create a novel and useful solutions (creative thinking) and monitor the success or failure of these new solutions (metacognitive skill of self-monitoring). Although useful in many situations domain independent measures do not predict as well as domain specific measures. Creative thinking was long considered domain-general. It is measured with questions that did not specify any particular domain, e.g., how many uses of a glass such as use for drinking or used as a paperweight. However, scholars have presented evidence indicating that creative thinking is also domain- or task-specific and not only as domain-general [4, 5]. For example, the Ariel Real Life Problem Solving developed, provides respondents with the opportunity to utilize domain-specific creative thinking ability in a wide variety of specific real-life situations. For example, in a playground bullying context the students would be asked to generate all the ways that a student could solve the bullying problem in the specific playground context.

Scope of Work

We investigated the role of domain independent creative thinking (Torrance Test of Creative Thinking) in the Multi-Mission Team Trainer (MMTT) environment. This simulation trains and assesses Navy Surface Warfare Officers in offensive and defensive tactics. Thus the context can be conceptualized as being a collaborative problem solving task [2].

Results and Conclusions

We found some support for our hypothesis but the effect sizes were very small, and not practically significant [3]. In our study with one exception, all of the creative thinking subscales were shown to be reliable (Alpha greater than .70). We then correlated our creative thinking measures with our retention and transfer measures. The creativity measures of fluency (-.29) and flexibility (.-34) were statistically significant but unexpectedly negative. It may be that the Navy training focuses on "school solutions" and does not reward fluency and flexibility.

Our current creative thinking research is building on our prior work in the Multi-Mission Team Trainer, and new measures have been designed specifically to assess domain-specific creative thinking in an immersive team training maintenance simulator. For example, a domain specific creative thinking fluency item would be to identify as many solutions to the maintenance troubleshooting problem you experienced in the simulation.

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09.

Drones, 3D Printing, and Project-Based Learning

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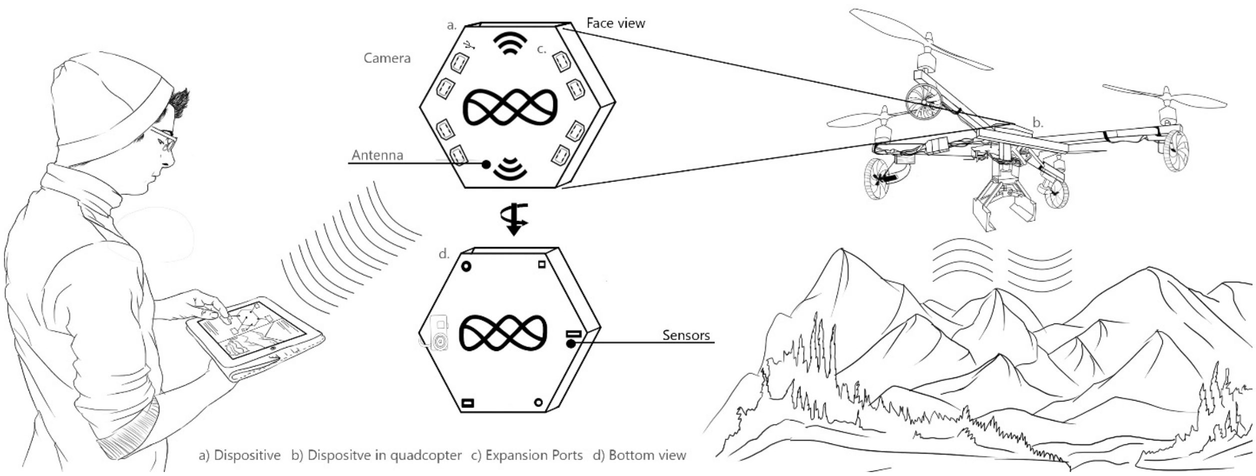
Abstract:

What if educators could lead the way in technological innovations such as reliable unmanned aerial vehicles (UAV) technology and 3D printing, guiding students through the dissemination of design, programming, functionality and the ethical ramifications involved--from concept to implementation? This presentation will demonstrate and discuss a project-based learning (PBL) learning experience where students created their own autonomous terrestrial and quadcopter drones using 3D printed parts. From design, to programming, to implementation, PBL encouraged the active and engaged learning that inspired students to obtain a deeper knowledge of the technology they were using—with real world application.

The artifacts created through these student projects are currently being used by Geology field researchers at The University of Texas at El Paso (UTEP) to capture visuals, in order to 3D map using point cloud technology. The technology is being used for reconnaissance, to quantify water resources, establish baselines of plants, animals, air quality, temperatures, and other factors that would be influenced by changing climate. The students are also currently designing their own propellers and other key components using 3D printing to keep costs low and provide additional custom design and functionality. The results obtained from this project will provide sufficient process data analysis to understand the benefits of utilizing additive manufacturing technologies for 3D structural electronics fabrication in building robust, reliable, UAV's as part of field research ecosystem.

One Sentence Summary: Research aimed at successful fabrication of unmanned aerial vehicles to be used for field research and teaching and learning activities through project-based learning.

Main Text:



(A) Figure 1 Prototype Sketch of UTEP UAV Quadcopter

University students are immersed in technology—it pervades nearly every aspect of their lives, in and out of a classroom. So much so, that in most cases, it is taken for granted, and the functionality of the tools/products remain "invisible" to its users. This is the hallmark of well-designed technology, and it's not until that functionality breaks down or is disrupted in some way, that most users will begin to ask, "How does this work?"

There are also emerging technologies that students only know from news stories—from unmanned drones being used for military spying and other nefarious purposes, or potentially a quicker, environmentally friendly, way packages might be delivered to our doorsteps. Or perhaps students are learning about the surge of low cost 3D printers that are producing artifacts that are flexible and/or durable, to produce anything from intricate designs to replacements parts for machinery (and even human "machinery" like tissue and prosthetics).

What if educators could lead the way in technological innovations such as reliable unmanned aerial vehicles (UAV) technology and 3D printing, guiding students through the dissemination of design, programming, functionality and the ethical ramifications involved--from concept to implementation? What if students began to ask "How does this work?" in their classrooms long before they adopt the technology in their lives on a daily basis?

This presentation will demonstrate and discuss a project-based learning (PBL) experience where students created their own autonomous terrestrial and quadcopter drones using 3D printed parts. From design, to programming, to implementation, PBL encouraged the active and engaged learning that inspires these students to obtain a deeper knowledge of the technology they were using—with real world application.

The artifacts created through these student projects are currently being used by Geology field researchers at The University of Texas at El Paso to capture visuals, in order to 3D map using point cloud technology. The technology is being used for reconnaissance, to quantify water resources, establish baselines of plants, animals, air quality, temperatures, and other factors that would be influenced by changing climate. The students are also currently designing their own propellers and other key components using 3D printing to keep costs low and provide additional custom design and functionality.

From Concept to Fabrication

(B) Figure 2 Prototype of UTEP UAV Quadcopter

The uniqueness of this UAV research is in the system of development. The design team has linked a mobile UAV to a ground based, hand-held tablet or computer that can download the information in real time as it is collected by instruments mounted on the mobile device. The communication between the mobile device and ground-based device facilitates taking control of the mobile UAV when circumstances indicate that would be advantageous to alter the flight path, to measure parameters, and incorporate algorithms to improve the resolution of data as needed. The system is able to do on-demand surveys, or autonomous surveys useful to field research, acquire specific photography of an area, or operate as a guided system to collect data where needed. In addition, the UAV is capable of exploring a pre-determined area on its own to get flags defined by the system.

The prototype is also cost effective (from $200-$300 depending on attached equipment), modular (for plug and play application "switch-out"), portable, and utilizes 3D printing to quickly and inexpensively replace parts in the field. Fabrication of novel three-dimensional (3D) structural electronic devices is continuing to be a major research initiative due to the advancement in additive manufacturing (AM) and multi-material 3D printing systems. For 3D structural electronics fabrication, AM provides the base fabrication process, with integrated subsystems to enable: 1) fabrication of complex geometries using a wide variety of robust thermoplastics / metals and 2) inclusion of sockets and channels within the design for embedding of electronic systems and wires within the part substrate and increased robustness. Collectively, the integrated technologies will fabricate complex electronics systems through multiple manufacturing systems, to provide multi-functional products, for various scientific field research. The development of new applications and tools will increase the potential of scientific researchers and students in a variety of disciplines yet to be explored.

Finally, the potential of advancing undergraduate and graduate student field-based research is unparalleled. The design team seeks to refine its development process of the larger faculty/research UAV's, into scaled down "student kits." This will enable students to literally participate in the construction of their knowledge, actively gather useful data for dissemination, at a low cost. The pedagogical rationale is framed by a problem-based learning (PBL) approach to teaching and learning. Problem-Based Learning is an inquiry-based approach that can be defined as both a curriculum and a process. The curriculum consists of carefully selected and designed problems that engage the learner in the process of acquiring critical knowledge, developing proficiency in problem solving, engaging in self-directed learning, and participating in collaborative teams. Current prototypes of the quadcopters have been student-driven, constructed and tested.

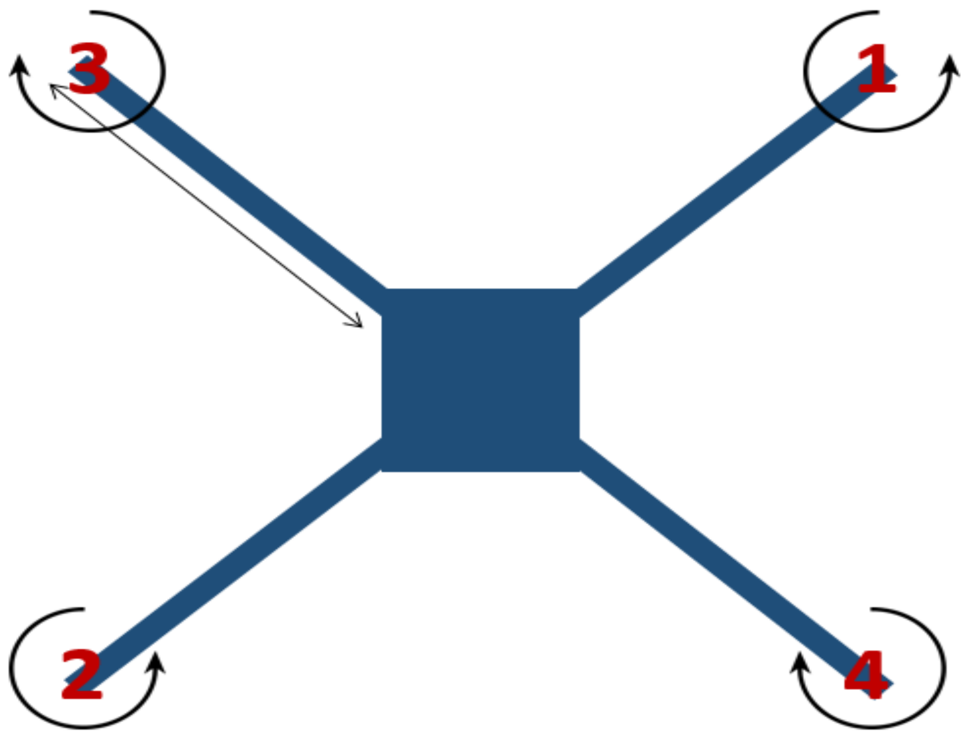
Design and Functionality Schematics for Quadcopter System with Attached Gripper

While other quad/rover systems consist of the rover and quadcopter acting as separate units, this system consists of the two units embedded as one. This design implements fuse deposition modeling to improve manufacturing costs and facilitates the replacement of parts. This system also consists of a gripper attached to the quadcopter frame for other applications. Such system can be used for sample gathering, data collecting, and the exploration of hard to reach terrains.

This design differs from other quadcopter systems due to its following unique features:

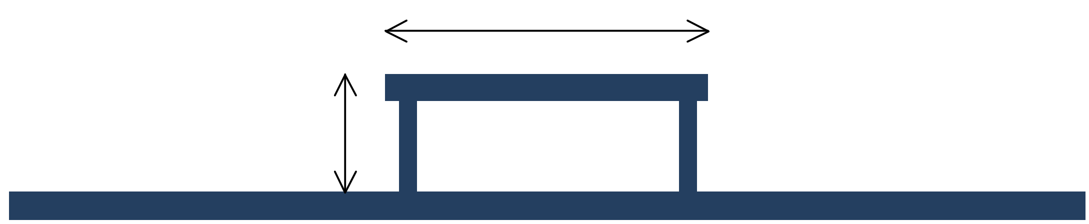
- Implementation of a unique PCB circuit board that links the quad and rover together.
- Gripper attached to quad used for collecting samples.
- A cost effective frame (provides a price reduction of more than 50% when compared to other professional quadcopter systems).
- Easy to replace 3D printed parts.
- Ability to traverse autonomously through both land and air as a single system.

This system uses x configuration. This configuration consists of propellers 3 and 4 rotating in a clockwise notation while propellers 1 and 2 rotate in a counterclockwise notation.



(C) Figure 3 Prototype Configuration of Propellers

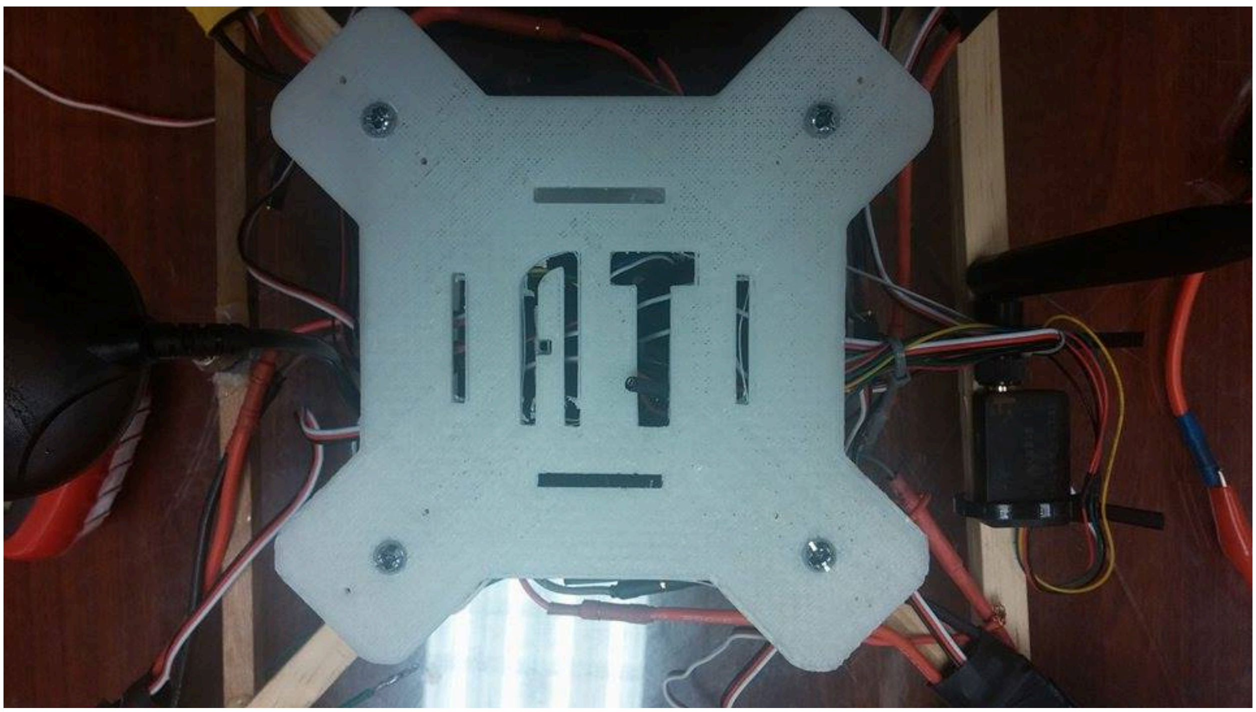
The base of the frame consists of two 3D printed levels that hold both components in charge of controlling the terrestrial and air components of the UAV.



System Model

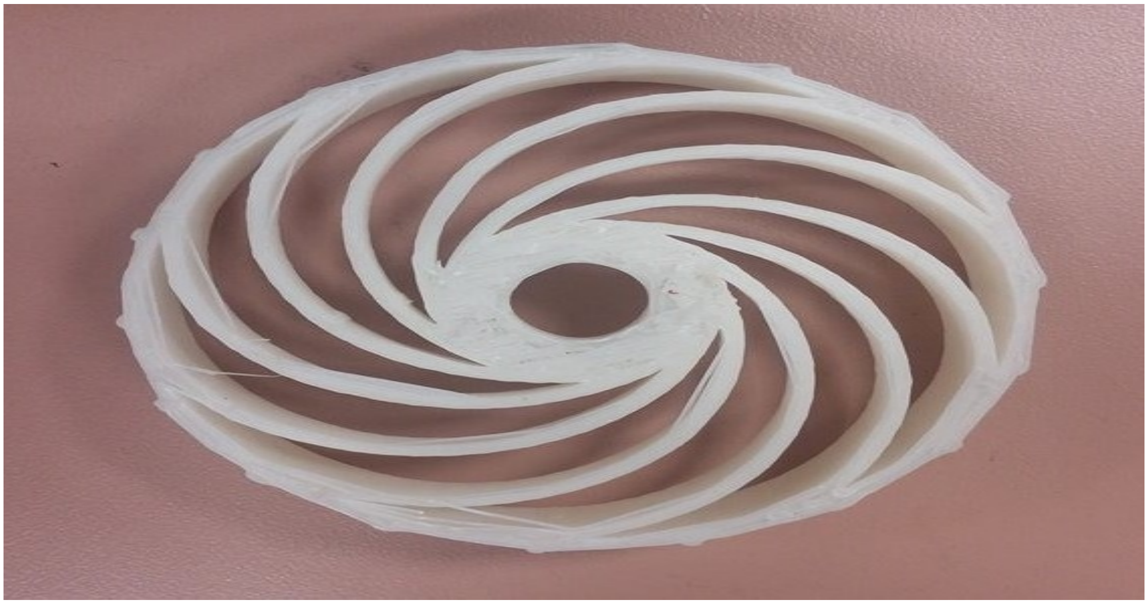
(D) **Figure 4** Graphic of Base Frame

This system consists of 3D printed parts which are mostly used for the frame of the UAV.



(E) **Figure 5** The 3D Printed Base Layer

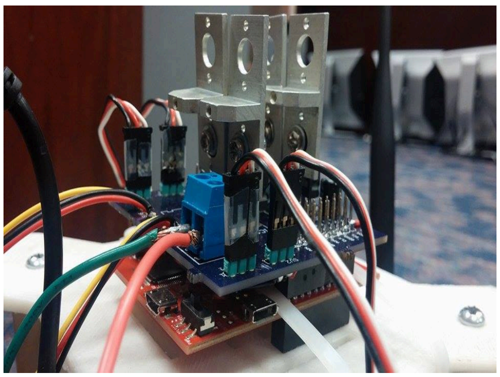
The four wheels of the system are also 3D printed. The wheels are designed in a spiral fashion to serve as a landing component for the quadcopter; its spiral shaped configuration provides a damping effect for when the quadcopter decides to land.

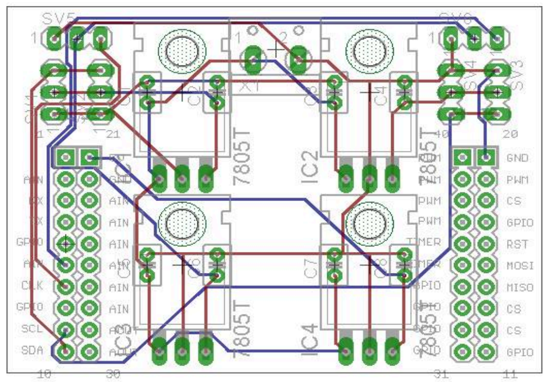


(F) **Figure 6** 3D Printed Wheel

Two infrared sensors are also implemented to provide the autonomous movement of the system. Objects are registered by these sensors and are avoided by the system. These sensors can pick up objects from the range of 10 to 80 cm. The addition of more sensors provides for more efficient and accurate terrestrial movement.

The PCB is mounted to a TIVA microcontroller that controls the terrestrial component of the UAV. This microprocessor feeds on the same battery source that controls the aerial component of the UAV. It is designed to control the servos used to rotate the wheels and the IR sensors. This was constructed by students as part of the project-based assignment.





(G) Figure 7 PCD

(H) Figure 8 Microprocessor

Sustaining and Building Enthusiasm for STEM

Another catalyst for this project was to increase enrollment and retention in STEM (Science, Technology, Engineering, Mathematics) courses at UTEP. There are many reasons why students entering college may not choose to major in a STEM field but we feel that two major reasons that we can address at UTEP are: 1) the lack of a good experience in mathematics and science before a student reaches college and 2) the large, impersonal introductory science classes that are common in many universities. When we asked STEM majors why they chose to major in a STEM field they often responded that there was family pressure to pursue an area of study that would make them successful, most commonly Medicine or Engineering, and/or they indicated they had one teacher in their pre-college classes that inspired them to go into STEM. In contrast, several students who did not choose to major in a STEM field indicated it was because they felt they were not “smart enough” or did not like science and/or mathematics. We take that to indicate they had a bad experience in mathematics and science classes before they entered college and they did not encounter that one teacher who could have changed their attitude.

To compound the problems related to their pre-college education, when they do reach the university students are usually required to take mathematics and science courses in what may be a very, uninspiring classroom. The introductory science courses are designed to teach a non-major everything they need to know about a particular science in one semester and they involve a lot of memorization. The introductory STEM courses are often taught by adjuncts and/or online but even with the best teachers and most personal approaches, we see only a very small percentage (<1%) of non-STEM majors change their major to a STEM field after taking a required STEM course. Many students put off taking the required mathematics and science courses as long as possible and that increases the difficulty of changing their major even if they did develop an interest based on an introductory class.

There is a need, then, for project-based instruction—unique classes that are likely to be of broad interest to non-STEM students, but include significant STEM content. Imagine a course where the goal would be for students to build their own UAV. They will be taught the basic principles of building a UAV with student kits and they will have to understand how the UAV works in terms of navigation. For example, to make a UAV go forward, you have to increase the rotation of the rear propeller, so that the UAV will tilt its rear side upward and direct the thrust toward the rear. This is necessary to propel the UAV forward, but it is not an intuitive concept for most people. Visualizing why this works that way will give students an understanding of some basic concepts in Physics and we could encourage them to calculate the amount of tilt, thrust, and which propeller engines need to do what (a vector math problem) in order to design their UAV. In the end, the students will have a working UAV that they built themselves. As John Dewey so famously pointed out, "Education is not preparation for life; education is life itself." Culture, context, and the social nature of learning all have a role in shaping the learner's experience. Why not bring these conditions into our understanding of technology for immersive exploration, examination and analysis?

(I) Media 1 UAV Project with Geological Sciences Video (https://youtu.be/Gl9vtzlRndM)

Additional Author Notes:

Oscar Delgado, Instructional Technologist. In his role with Creative Studios in Academic Technologies, Mr. Delgado serves as a software programmer, developer and researcher for a wide range of projects related to websites, applications, and networking. He works within all stages of research, design and development of applications for enhancing instruction. His primary focus is working with servers and security, web programming, content-management systems and web platforms (Joomla!, Drupal, WordPress, DNN), 3D Technologies, and mobile applications.

Steven T. Varela, Associate Director/Faculty. In his role with Creative Studios in Academic Technologies, Mr. Varela oversees the Creative Studios and Teaching and Learning Laboratory areas of AT, which is responsible for graphic design, software and web programming, emerging technologies and professional development. As a faculty member, he is an expert in curriculum/instructional course design and development for fully online, blended and tech-enhanced courses, and teaching with technology. Mr. Varela is skilled in using multimedia and multimodal approaches to teaching, learning and design, as well as specializing in *gamification* and immersive technologies.

Guillermo Vargas, Graduate Student. In his role with Creative Studios in Academic Technologies, Mr. Vargas is a graduate student-staff member. He is studying currently studying Geophysics at The University of Texas at El Paso.

10.

Operations training using immersive technologies – A development experience

Authors: A. Aman, E. Tang, F. Harrassi

Affiliations: NA

Summary: Immersive technologies contribute to enhanced competency training in oil and gas sector and the development of local digital media sector in the Sultanate of Oman

Abstract:

Omanisation was established to increase job opportunities for national employment in Sultanate of Oman. With half of the population below 25 years of age, the sultanate is striving to diversify the economy fast enough to meet the burgeoning number of jobseekers annually. On the other hand, training personnel to be competent oil and gas operators and technicians is a difficult task in a complex reservoir structures in Oman using highly advanced and sophisticated extracting processes. Coupled towards Omanisation which encourages nationals into the oil and gas sector so as to create sustainable employment for the local population, the challenge to churn out competent manpower became a daunting task. Immersive technologies provided the impetus to create a new digital media sector which provided job opportunities as well as the learning contents to enhance the competency-based training for the oil and gas sector in the Sultanate. This lead to a win-win-win collaboration amongst the government represented by the Information Technology Authority (ITA), private sector specialised company (represented by ASM Technologies), jobseekers and oil and gas organisations. A pilot phase was conducted for 8 months to develop four virtual applications for training in equipment and process engineering; oil rig familiarisation, Health Safety Environment (HSE) application, turbine application and the mechanical vapour compressor (MVC) water recycling plant in order to enhance the competency level of the trainees. Concurrently, these applications were developed by local Omani resources within the country. Hence, it also contributes to the creation of a digital media sector in the sultanate.

Main Text:

Introduction

Oil and gas sector accounts for about 81.8% [1]of the Total Revenue in the Sultanate of Oman. However, the complex reservoir structures associated with the sultanate's hydrocarbons wealth means that the task of sourcing personnel with appropriate knowledge and skills has always been a challenge for both the government and the oil companies.[2] Coupled with the government's ambitious Omanisation targets aimed at introducing more nationals into the workforce across a range of sectors, competencies and skills training remain one of the key challenges in meeting the Omanisation targets. This long-term project has been in

[1] Source: Annual Statistical Yearbook Oman 2014

[2] Source: http://www.oxfordbusinessgroup.com/analysis/developing-workforce-omanisation-has-created-both-challenges-and-opportunities

operation since 1988 and has played an important part in the gradual replacement of expatriates with suitably trained nationals in the oil and gas industry.

According to a study in 2014, it is reported that the oil and gas industry currently employs 55,000 people out of which 22,369 are Omanis (an Omanization rate of 40.6 per cent). The direct workforce of the oil and gas companies is currently 8,991 with an Omanisation rate of 63 per cent. In the service providers' workforce, the Omanisation rate is pegged at 59 per cent. The construction sector which contributes the highest number of jobs within the oil and gas industry has a comparatively low Omanisation rate of 25 per cent.[3] Overall, the service providers and construction sector constitute 82 per cent of the jobs in the oil and gas industry.

By 2020, the oil and gas industry's estimated total manpower requirement will be 72,704. To leverage the enhanced job opportunities, the strategy envisages an education and training programme for 36,020 Omanis to take up mainly semi-skilled and medium-to-high end positions in the industry.

In this document, the phrasal approach in developing the local digital media sector as well as the challenges faced in developing immersive solutions for training oil and gas technicians and operators will be discussed.

Jobseekers’ Challenge

The number of job seekers in the sultanate has registered a 2.6 per cent average annual growth over the 2003-2010 period, totaling 146,385 people and forming 11.75 per cent of the nation’s workforce[4]. About 98.92 per cent of these job seekers are Omani citizens. The percentage of jobseekers in the age group from 15-24 years is 63.6 per cent in 2010. These youth group has at least High School Diploma and they are IT, internet and social media savvy. They are young, dynamic, energetic, and exude positive aura. They are usually full of hope and aspirations but can also have unrealistic target and expectations. With larger number of female in this group, it would therefore be more fruitful to deliver programmes that will be able to serve their needs and empower these young women to be successful citizens who could contribute effectively to the growth of the Sultanate.

Since they are young and energetic, such energy can be diverted towards creative energy. The digital media capacity building programme aimed at channelling such creative minds to contribute effectively in the economic development of the Sultanate. Hence, equipping them with the skills and knowledge in the digital media and immersive technologies field would benefit the jobseekers to be skilled professionals as well as technopreneurs.

Training Challenges

Hiring and retaining qualified staff, has become a costly business in terms of both time and capital. Not surprisingly both the government and the private sector have already invested significant sums in training Omanis to work at all stages of the hydrocarbons business, from exploration to refining and distribution. Knowledge retention is key in capacity building for the oil and gas sector in Oman so as to meet the Omanisation challenge in the coming years. Some challenges in competencies training in oil and gas sector in Oman;

a. Training of technicians and operators. These are mainly high school graduates or diploma holders from local Technical or Vocational Institutions. There is a need to train them on specific skills for oil and gas industries.
b. The complex reservoir structures required sophisticated enhanced oil recovery methods. Such methods required various types of specialised training in order to be competent field operators and

[3] Source: http://www.oeronline.com/php/2014/jan/oilandgas.php
[4] Source: National Center for Statistics and Information, Aug 2015

technicians. Traditional methods of teaching such as classroom lectures, on-job-training and competencies assessment are the main methodology used. Videos are often used in a linear mode so that trainees could visualised some of the oil field operations.

c. Language barrier posed another challenge for the local Omani trainees. Since Arabic is their main language and English is taught as a second language, their understanding of English technical terminology in the training can be quite an issue.

Use of Immersive Technology for Oil and Gas Operations Training

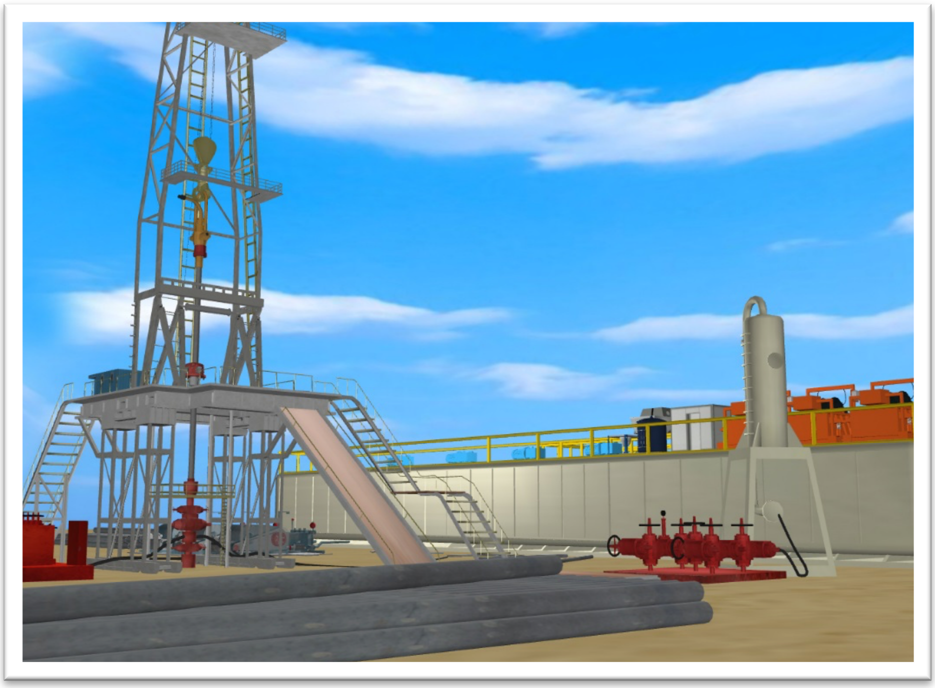
Confucius' said, "I hear and I forget. I see and I remember. I do and I understand." This is the core concept in the adaptation of immersive technologies for capacity building in the digital media sector as well as operational training for oil and gas industries.

A pilot phase was carried out with two major international companies in Oman to test out this concepts;

Company A Projects

A1 - Oil Rig Familiarisation

A 3 month Interactive Digital Media and Virtual Reality Training Programme was conducted to a group of 40 trainees which were divided into 8 project groups. This course started in 2013 as part of the capacity building initiative by the government. For this particular batch, one of the groups developed the Rig familiarisation programme using virtual reality application. The objectives of the programme was to introduce new employees or trainees to the oil drilling rigs. The Subject Matter Experts from the company provided the materials and information for the team to develop the project. The team were given technical training in graphics enhancement, 3D modeling and coding for virtual reality application. The team developed script and storyboards to provide the foundation for the development process. This include image enhancement, modelling, texturing, animation and coding the interactivity into an immersive programme. The final programme was shown using the CONCAVE at the SAS Center for Virtual Reality. The following are some of the screenshots from the completed programme.



Picture 1 – Overview of the Rig environment

Picture 2 – Information on one of the components

Picture 3 – Team meeting between the developers and the Subject Matter Experts

A2 - Confined Space Virtual Reality Content

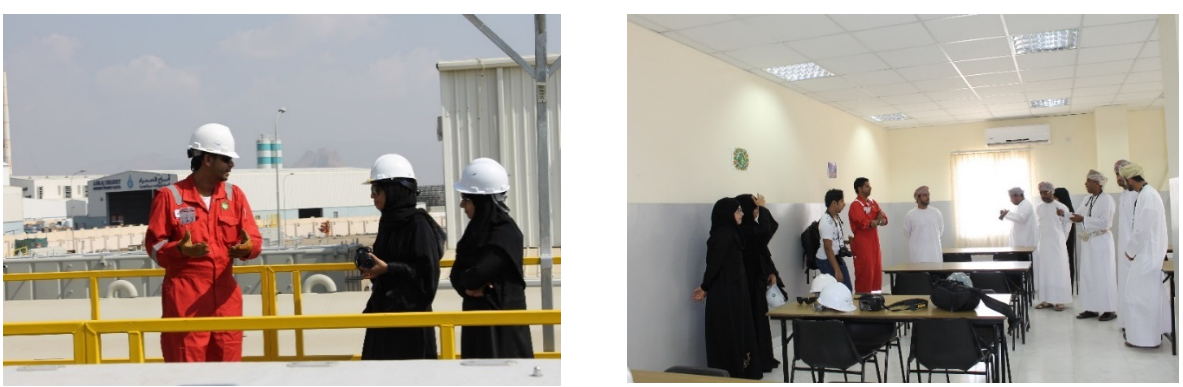
Another group comprising 10 pre-incubatees (trainees who graduated from the 3 month and proceed to the Phase 2 of the programme which prepared them to be technopreneurs). Part of the programme includes a 6 month project development for an actual client. In this case, company A provided the subject matter expertise and the information required.

This team developed a HSE topic entitled confined space entry. The objectives of this content includes definition of a confined space, testing process before entering a confined space, list the safety equipment and the hazards involved when entering the confined space. The team were given additional training on Instructional Design, Project Management and Coding for Cave environment. The team also developed script and storyboards to provide the foundation for the development process. This include image enhancement, modelling, texturing, animation and coding the interactivity into an immersive programme.

The final programme was shown using the Cave environment at the SAS Center for Virtual Reality. The following are some of the screenshots from the completed programme.

Picture 4 – Screenshot from the iCube on the Confined Space Entry Programme

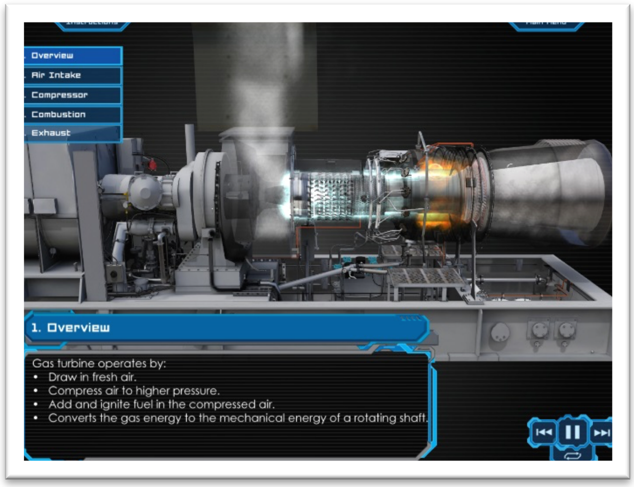
Picture 5 – Screenshot from the iCube on the Confined Space Entry Programme



Picture 6 – Site Visit to Nizwa Industrial Site by the Pre-incubatees

Company B Projects

Two applications are developed; one for enhanced oil recovery (EOR) process and the other on engineering training. The Mechanical Vapor Compressor (MVC) is water desalination plant used to recycle contaminated water into distilled water for use in the oil extraction process. The MVC system contains complex mechanical, chemical and process engineering. The main challenge in training operators and technicians in this system is the lack of visualization and interactivity components in traditional training methods.



The gas turbine basically converts the energy of a moving stream of fluid either liquid, water, steam or gas into mechanical energy. Turbines are used in the oil field to provide electricity and power for the operations. Similarly training operators and technicians to operate and maintain the turbine package is a daunting task as the system is highly automated and mechanised.

There are 2 Trainers application; one for Turbine and one for MVC. The trainers' versions are incorporated into the Electronic Tasks Book which is used to evaluate their skills and competencies in 3 levels; Level 1, Level 2 and Level 3.

a. Using EON ICatcher solution

The turbine package was developed using 3D max and EON Studio 8.6 for interactive stereographic application. The application comprised 4 main module; Working Principles, Main Components, Start Sequence and Basic Troubleshooting techniques. Using the ICatcher solution and a 3D projector, the Trainer used the application to teach the trainees who used the 3D glasses to view it in immersive environment. Voice over is added to provide explanation in some scenes to ensure contents are accurate and consistent with all Trainers. This helps to standardise the information provided by the Trainers to the trainees.

Media 1.0 – An overview of Turbine Virtual Reality Application

b. Using Unity and TechViz Immersive Solution

For the MVC system, the team developed the models using 3D max and integrated the models into Unity for animation and interactivity.

This application requires the use of millions of particles and polygons to depict realistic water, vapour and oil flow in a progress engineering environment.

From conceptualistion, development and implementation of this application, there are numerous artistic, technical and operations challenges that could hamper this project.

Media 2.0 – An overview of Mechanical Vapor Compression Virtual Reality Application

a. The main challenge in development this application in virtual reality is to show realistic fluid flow in multiple-shaped vessels, equipment and various sizes of pipes in different dimensions, some long and some with curved joins and corners. The artistic team is challenged to make the models as realistic as possible using limited number of polygons and textures. Despite that, the entire models comprising some 36 vessels, equipment and main components and several hundred pipes are eventually formed by about 3.7 million polygons and several millions moving particles to depict water, vapour and oil movement.

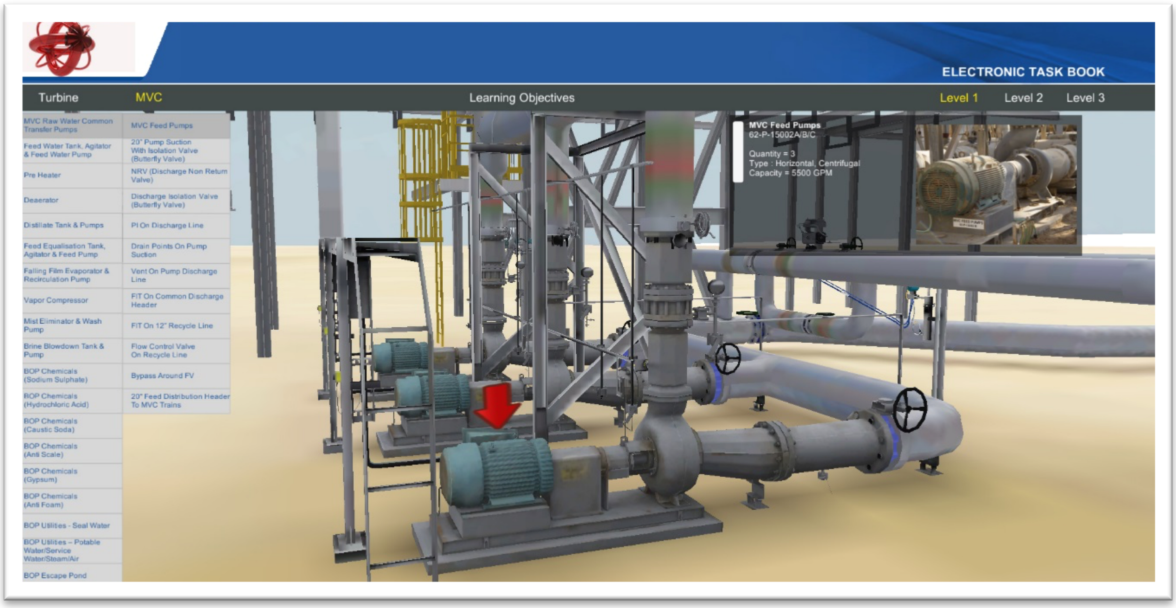
b. Integration of all the models and environment posed another issues of performance in stereographic. The integration of models comprising more 3.7 million polygons and million more participles tend to slow down the application in stereography. Hence, a high-end i7 server with 32GB Ram and Nvidia Quadro K6000 Graphics card - 12 GB - GDDR5 SDRAM is used with Techviz Stereographic solution.

c. Operations functionality versus artistic display posed another issue for the team. Numerous revisions have to be made so that the operational functionalities of each component are met whilst the models look great in stereographic 3D.

There are 3 main modules in the final application; Working Principles of the MVC, Main equipment and vessels and Troubleshooting.

An overview version to show the water flow process is developed for Oculus Rift which provides a summary of the entire process for the new trainees. In this immersive environment, trainees can explore and view the entire environment safely and interactively.

Knowledge Application and Retention with Electronic Task Books



Picture 7 – Electronic Task Book Application for one of the Level 1 tasks in the Enhanced Oil Recovery System

Picture 8 – Electronic Task Book Application for one of the Level 2 tasks in the Enhanced Oil Recovery System

The Electronic Task Books are the Trainees' version of the application. The task book is adapted from the manual version which contained sets of tasks in which the trainees had to perform at each level as depicted in Table 1.0

Tasks	Descriptions
Category L1 Tasks	1. Locate and identify the equipment. 2. On the enclosed worksheet, describe the function and operation of the equipment and where applicable, the set point using manufacturer's data, P&ID).
Category L2 Tasks	1. Operate, monitor, control and item of equipment or process. 2. Where applicable, verify all safety & shutdown systems are on line and operational.
Category L3 Tasks	1. Demonstrate the correct procedures to isolate, reinstate, and test the equipment. 2. Identify cause & effect when the equipment alarms or fails.

Table 1.0 – List of tasks in the electronic task book

As each Trainee completes the task level required for his Personal Training Plan, he is then eligible to carry out the competency test laid out in the Competence Assessment.

Evaluation by Subject Matter Experts and Trainees

A formative evaluation is currently being done for the Turbine and MVC application in this pilot phase from May to July 2015. The contents are shown to the subject matter experts from the operations as well as the training departments. Sample Trainees from the On-job-training (OJT) phase will also participate in the evaluation (sample size). The purpose of the evaluation is to obtain feedback on the immersive contents from the trainers, operators and trainees on how immersive technologies enable them to understand better and retain critical operations information longer. Qualitative and quantitative forms of evaluation is being done. Initial findings indicated that the SMEs and the Trainees find the applications visually stunning and they could understand the process flow as when as the working principles of all the components very clearly. The finalised results of the findings from the various groups will be depicted in the following manner and is currently still ongoing.

1. Subject Matter Experts (Trainers) for Turbine and MVC
2. Subject Matter Experts (Operation Supervisors) for Turbine and MVC
3. Trainees (OJT) for Turbine and MVC

Creation of a local digital media sector

An interesting outcome of this pilot project is development of a local digital media sector in the Sultanate of Oman. This project is developed by the SAS Center for Virtual Reality. The SAS VR Center is established as a joint-investment project between the Information Technology Authority of the Sultanate of Oman, EON Reality Inc, the Virtual Reality Technology Provider and ASM Technologies LLC, the Digital Media Specialist in Oman. The Center spearheads the development of digital media cluster in Oman with expertise in 3D Animation and Virtual Reality technologies in the next 5 years; providing eContent solutions, developing local resources, creating job opportunities and exporting local intellectual propriety as well as products and services to the region.

The main objectives of the Center are:

- Provide Omani people with the education, skills and knowledge around Digital Media and Application Development to become the employees of choice for new high-value added positions.
- Use latest digital media technologies and application development to design, communicate, collaborate and accelerate learning and knowledge transfer
- Creating a technology infrastructure platform that is highly conducive to entrepreneurship and innovation.
- Develop digital media and application development contents
- Encourage research and development in local universities to further develop the platform as a part of the new Oman knowledge-based economy
- Providing a leading edge innovation and IP, this will help Oman tap into the global knowledge economy.

Capacity Building and Technology Transfer

The key to technology transfer is training and development in digital media and virtual reality technologies. The center over a period of 5 years will train a total of 600 Omanis. As of June 2015, a total of 320 Omanis have completed the technical training and 60 of them are now developing contents for the industries under the SAS VR's pre-incubation programme. These pre-incubatees would be encouraged to form their own specialized companies in the digital media sector to support the local industries. Til date 17 companies have already being formed.

A group of 13 Omani graduates from this programme formed the main resources in developing the 3D models for the turbine and MVC applications. By developing alongside professional developers, these jobseekers are able to apply the techniques acquired during the training into real projects for real clients. Such exposure serves to bolster the graduates' experiences and enable them to be gain employment in the digital media sector. In addition, the center also prides itself with a highly customized programme to transfer the digital media and virtual reality technology knowledge to the local workforce. This is a truly win-win-win collaborations between the SAS Center for Virtual Reality, oil and Gas Company and the Omani jobseekers. These contents are developed in Oman by young talented Omanis for the Omani oil and gas sector.

Conclusion

The development of these projects for oil and gas training and operations push the boundaries of virtual reality applications into another dimension; using immersive technical to train and simulate operations environment. There are many challenges that the team faced in developing these applications and the lessons learned in overcoming these challenges. Through the Immersive Education Summit, the team also hopes to share experiences and learn from others who have successfully implemented such immersive solution in operations settings and in support of capacity building.

11.

HauntedYYC

Category: Presentation

Title: HauntedYYC

Author: Stefan Rasporich

Abstract: HauntedYYC is an interdisciplinary field trip that puts students in the role of both paranormal investigator and historian. Using Sesame Snap as a QR-code content delivery system, students unlock clues in real time to follow an epic battle between inter-dimensional beings in a local neighbourhood.

They learn about local history, meet local business owners and develop critical and creative thinking skills as they work collaboratively towards a goal.

I was inspired to attempt his project when I met Neal Edelstein filming his innovative horror movie "Haunting Melissa" delivered as an app. He took the time to describe to me how this gripping story would be made available at unknown intervals to a mobile audience.

Summary: Assessing the educational value of an interdisciplinary field trip that features interactive storytelling about local history.

Main Text:

Slide 1: Paris Immersion iED

Messieurs-dames, bonjour, hello everyone...my name is Stefan Rasporich

I am both humbled and honoured today to have been selected to share my work with such an inspiring and innovative community.

A quick note before we get started – a prize will go to the observant paranormal investigator who can spot the hidden monkeys that appear in most slides, so keep count.

Slide 2: Another Monkey Productions

Another Monkey Productions presents “HauntedYYC: Is it worth a redesign?”

YYC is the airport code for Calgary, Alberta, Canada where I work as an Arts Educator at the Calgary Arts Academy, a public charter school.

There are two stories I want to relate today: my personal story in developing HauntedYYC as an interactive field trip for junior high students and the true, yet paranormal, story of Barney the Monkey.

And yes, the first prize monkey is peeking out from the bottom right hand corner. One down.

Slide 3: Introduction to S. Rasporich

First, my story…

I teach social studies and filmmaking to grade 8 and 9 students. As a screenwriter and actor, I’ve had a lot of exposure to storytelling as an art form.

However, game design is something I have a new-found passion for and have realized how highly engaging gamification can be for my students.

Slide 4: The Story Begins

HauntedYYC began when I met Neal Edelstein, the director and producer of Haunting Melissa. He was filming down the hall in the historical apartment building where I live.

I asked Neal what he was filming and he described to me the unique way he was telling the story – through an app. He had teamed up with Apple to offer a horror movie that not only arrived on your device at unknown intervals, but changed when you reviewed it.

This was the first time I considered transmedia as a possible means of delivering a narrative and was inspired to try something myself.

On a whim, I entered the first prototype for HauntedYYC to a pitching contest in the transmedia conference - StoryWorld Quest.

Slide 5 – Story World Quest

To my surprise, our team was a finalist and we pitched the idea of immersing the audience in a narrative by taking them on an interactive scavenger hunt through a haunted neighbourhood.

Slide 6: PitchQuest Video

Here is the video we prepared for PitchQuest.

(Show video)

We didn't win PitchQuest and I can't "fugure out why" but we received a lot of feedback encouraging of our work. I shelved HauntedYYC, but still wanted to believe in it.

This might be a good moment to diverge from my story and learn more about Barney the Monkey's.

Slide 7: Barney the Monkey's Story

In the black and white photograph, you will notice the figure of Cappy Smart, Calgary's first fire chief, who had a taste for exotic pets, like monkeys.

Slide 8: The Hose and Hound

In the full colour photo you can see the modern version of the firehall, now a bar and restaurant called "The Hose and Hound."

Slide 9: Barney's Version

Barney's story is...haunting. One day in the early 1900's, the firefighters had to respond to a call and tied Barney to a flagpole in front of the station. While they were gone, a mother walked by with her son who was curious about the monkey.

Unfortunately, Barney attacked the child and upon the firefighter's return, was put down. Ever since, paranormal activity has been reported at the Hose and Hound with accounts of appliances turning off and on and items flying in the kitchen.

Can you see how it was so difficult to let this story go? It's compelling.

Slide 10: Escape Games

Fortunately, later in the school year, when I was having students design Escape Games to learn about Japanese history, an opportunity arose – admin asked us to use up the field trip budget by year-end.

I decided to revive HauntedYYC as a large-scale escape game field trip where Barney the Monkey played a pivotal role. By following his trail, the user would get to the next clue and trigger their escape.

Slide 11: Inglewood as the Escape Room

In this escape game, the neighborhood of Inglewood would be the **room** and students would have to complete a timed objective inside that would test their skills of observation combined with knowledge of local history in order to get free.

To engage them in a storyline, I constructed a video narrative where an inter-dimensional being was imprisoned by his twin brother and was seeking help from the viewer. The monkey had already bridged the two worlds and was being sought by both twins.

Slide 12: Sesame Intro Video

Here's a sample video that introduces the twin brothers.

(play video)

The intro video sets the students on an adventure where they would find hidden locations in Inglewood and take "7 Deadly Selfies" on their path to freedom.

Slide 13: The Visitor's Guide, an iBook

Students in this game would use iPads as a medium in the field because I had previously created an iBook called "The Visitor's Guide to the Paranormal."

The guide had many interactive features all ready for use and if you like, you can download it free from iBooks. Cover image courtesy of our trip to the catacombs here in Paris.

Slide 14. Creative Limits

I had read that great designers would deliberately impose creative limits and I fortunately already had two for the escape game field trip: I had no access to a wifi network for using the iPads outside and...I had no budget.

So, with both of these limits in mind, I set about collecting free assets for the Visitor's Guide and making it interactive without needing wifi.

Slide 15. Freebies

I gathered royalty-free sound effects, Collada 3d images, images from the Glenbow archives, took photographs of Inglewood and got to work using iBooks author to put them all together.

Slide 16: Not So Open Sesame

At this point in my story of developing HauntedYYC, I made a mistake. I abandoned the creative limitation of not having wifi.

Why? Because I got carried away thinking *how wonderful* it would be for students to use Sesame Snap, this amazing new learning management system our school was trying out that the student could interact with and be assessed at the same time (and because Fort Calgary allowed us to access their wifi network.)

So I used Sesame's QR codes to create historical characters as registered students and set videos to stream when students found clues...

I made at least 11 videos per group, times 6 groups, uh-oh, 66 videos!

Slide 17: No Wifi, Remember?

Let's recall the no-wifi idea for a moment. Two days before the field trip I decided to be responsible and test the wifi network at historic Fort Calgary where the climax of the twins narrative and the monkey would take place.

You may be able to guess what's going to happen next.

Slide 18: Fort Calgary

The wifi was pre-historic in the level of bandwidth it offered and only allowed two seconds of video before grinding to a complete and utter halt.

Slide 19: Videos in iBooks Author

All of these video files I had put into Sesame Snap were about to be useless without wifi to access them. Backfire.

As a last-ditch effort, I made a separate Visitor's Guide with all of the video clues jammed into it subtitled the "Field Guide."

Slide 20: The Field Guide

This seemed to solve the problem but I still had to wait 24 hours to see if Apple iBooks would process the Field Guide in time.

As luck would have it, the next day the Field Guide was up on the iBooks store **but** it had supernaturally reverted to the wrong version.

Perhaps this was the monkey at work. Armed with his unholy wrench.

Slide 21: Despair

In screenwriting terminology, this moment is the Act II turning point where the protagonist has to believe they have no hope of ever achieving their goal as the inevitable deadline approaches.

It feels like death.

Miraculously, our school's tech angel suggest I upload a proof of the Field Guide **directly** from my computer to our 20 iPads. Such a simple and direct solution, I would never have thought of it and of course, it worked.

Slide 22: Hot Weather at the Field Trip

The day arrived in June for the HauntedYYC field trip and it was full of surprises. At first I prayed it wouldn't rain on the iPads.

Instead, the weather decided to scorch us with 34 degree Celsius heat, and to add to the joy many students forgot their water bottles.

Slide 23: The Day of the Field Trip

I briefed parent volunteers in the early morning on how to use the iPads with this clunky and confusing set of videos I'd put together. They were patient and kind and followed along as best they could.

Despite problems with the screaming noise from the rail and car traffic drowning out the audio, plus the glaring light from the sun making video hard to see, students seemed to genuinely have fun in taking selfies and exploring a neighbourhood many of them had taken for granted.

Slide 24: The End of the Field Trip

I had wanted to experiment with using social media and tried using "Snapchat" which had a nice ghostlike template in line with the visual themes of HauntedYYC.

Slide 25: Snapchat

A handful of students tried it.

Slide 26: The End

Then we had lunch and went into Fort Calgary for the climactic final showdown of HauntedYYC. There, inside shelter and air conditioning, the videos were clearer, clues easier to find, people found happiness.

They tried on Mountie uniforms and had fun in discovering the end of the story where the bad guy was imprisoned and the monkey ghost continued on to disturb another neighbourhood in YYC.

It wasn't fully what I was aiming for from an educational standpoint in terms of learning about local history, but at least I was starting to see the kind of engagement and teamwork I had hoped for.

Slide 27: The Whole Truth

In the aftermath, the participants filled out surveys giving me valuable feedback to help decide whether or not the Pandora's Box of HauntedYYC should ever be opened again.

Slide 28: Adult Feedback

I asked parents, resident artists and teachers for their feedback to get a better sense of whether the trip was worth a redesign. Here is a sample:

Stefan,

I was very impressed by all the work that went into creating an engaging interdisciplinary experience. The pacing was brisk and allowed for all students to participate in a variety of unique learning experiences, relevant to their experiences as citizens of Calgary. Thank you so much for your constant effort and instilling wonder in our students.

DT

Dylan Thomas

Team Leader

That was positive! Now for some needed suggestions for improvement:

- Clean up the audio so the creepy distortion for the bad guy can still be understood.
- Include subtitles with the audio.
- Include a copy of the shooting script for reference.

Slide 29: Student Feedback

And here's what students thought:

<u>Successes</u>

"really needed the Visitor's guide, would've been lost without it."

"liked the selfies"

"enjoyed working as a team to figure it out"

"night activity would be awesome" (and colder)

"a night version everyone could have a flashlight/glowsticks"

"enjoyed seeing diverse parts of the neighbourhood"

"tone of the videos was creepy/mysterious"

<u>To Improve</u>

"have real clues, not on the iPad"

"just ended up going to Starbucks"

"couldn't figure out the letter clues"

"night activity would be sketchy"

"have a clear objective, make it finishable, make sure it works, more challenging"

"something to find at the end"

"too confusing"

“have spare water bottles”

“maybe develop a specific app with cached information so its not dependent on a network”

“competition would be an interesting twist”

I want to believe a redesign of HauntedYYC is worth pursuing. At the very least, I’ve found the design process has proved valuable for my own professional development – a mixture of failures, insights and iterations.

If there is a redesign in the works, there are some ideas I’d like to try out…

Slide 30: Widgets for Smartphones 13 min

The new iBooks Author update uses Epub3 which makes it possible to make the Visitor’s Guide available for a smartphone.

Even better, while experimenting with the update I discovered Bookry.com and an array of great HTML5 widgets, all for free.

My personal favourite is the “Scratch n’ Reveal” widget and I designed this one so the user scratches away at a modern day image of Fort Calgary’s buffalo sculpture to reveal an historic image hidden underneath.

Slide 31: Closer

What’s even better is an audio file plays while the user scratches. I chose a speech in Blackfoot to reinforce the idea of how life would’ve sounded in the 1870’s and believe it will advance my learning objectives about local history in a very fun way.

Slide 32: Universal Design for Learning (UDL) and Community Involvement

I'm interested in applying the concepts of Universal Design for Learning, or UDL, such as having captions for those who are hard of hearing. UDL design modifications have proven to benefit other users in unforeseen ways and this sample shooting script could be such a modification.

Slide 33: Inglewood BRZ

Also, the attached letter illustrates how this field trip was an opportunity to build community and reach out to local businesses. The Inglewood Business Revitalization Zone was delighted to participate and encouraging of the learning experience.

Slide 34: HauntedYYC and Virtual Worlds

I use virtual immersive worlds as a teaching and learning tool, and Minecraft is my prefererred medium. On the Minecraft servers I host, students access hyperlinked information on the web through command blocks.

For HauntedYYC, I would build a scale version neighbourhood of Inglewood as a preview of the escape game field trip, a reflection afterwards, or a complete substitute in case of...unlucky weather.

Slide 35: HauntedYYC

To wrap up, the stories of both myself and Barney the Monkey are clearly intertwined on more than one level. And we both may live to see another neighbourhood.

My teaching team is interested in doing an interdisciplinary version of the gamified field trip at Heritage Park, a historical village where even more supernatural activity has been witnessed than in Inglewood.

The poor souls. They know not-what-they-do.

Questions and Answers

<u>Questions?</u>

My question first – who noticed the most monkeys? You win a prize!

Acknowledgements:

CAA

Glenbow Museum Archives

Another Monkey Productions

Reworks

Spolumbo's

Moonstone Creations

Smithbilt

The Hose and Hound

Fort Calgary

Artesano

Bhawana Clark

Rouge Restaurant

Inglewood BRZ

Media

Media #1: PitchQuest video, "HauntedYYC"

Media #2: Sample intro video, "Spencer vs. OGG"

Media #3: Photographs of variety of selfies including Snapchat, Sesame and taken from iPad, NWMP and Mountie attire

Media #4: "Visitor's Guide To the Paranormal"

Supplementary Materials

Supplementary Materials #1: Student survey samples

Supplementary Materials #2: Adult volunteer feedback

Hi Mr. R

Just thought I'd give you some feedback on the field trip today - I overheard you mention to one of the other parents that you were looking for that. First off let me just say Thank-you for all of your hard work. What a tremendous effort you put into this. Our kids are so lucky to have you going above and beyond for their education.

We parents are very lucky too!

I'm sure my insights will echo the others but for the record here are a few thoughts:

The morning scavenger hunt felt a little ambitious in terms of the time required to get to each of the stops - I never did get all the way to Rouge with a group. I realize we started a little late and I know that set the tone for things and everything felt like it was running behind after that. Perhaps just 2 groups in the morning would have felt more manageable.

I thought the video clues were super creative but I saw the kids losing interest - I think they were frustrated by the sound challenges and the voice distortion. I noticed a pattern that repeated in each of my groups and that was that one person (the alpha) tended to take the lead with the iPad and at least a couple of the others tuned out. Perhaps there could be some components that aren't on the iPad so that the students need to work collaboratively to solve a clue.

Theres no point mentioning weather or trains because they're things you have no control over but I did want to mention lastly that perhaps a sun shield for the iPad would have made viewing a little easier.

Thanks so much again for everything!

Supplementary Materials #3: Physical game pieces: Dominos, laminated domino clues, QR Codes, Snapcodes

Supplementary Materials #4: Field trip documents: schedule, field trip form, random groupings, parent visual walkthrough, student info,

Supplementary Materials #5: iBook download links – Visitor's Guide and Field Guide with videos

Stefan's Paranormal Experience: Here's an interesting part of my story I haven't mentioned, and oddly brings everything full circle. In my twenties, I worked at Fort Calgary as an interpreter giving tours to tourists from the UK, France, and the United States. One day, we decided to host a tipi-raising from a Blackfoot family. I offered the owner to sleep in the tipi overnight so if anyone came by, I could make sure it was kept safe. He accepted and I settled down on some buffalo robes to catch some sleep. Now in that sleep, I cannot tell you if I was dreaming or not, but at one point I woke up to find an entity hovering above me - close to my face, and blocking out the streetlight that came in through the top of the tipi.

The next day, I asked the Blackfoot man about it and he just laughed and said "that's nothing. Things like that happen all the time." I was astounded. Upon reflection, perhaps it was Barney's monkey spirit planting the seed for me to develop HauntedYYC that would be realized twenty years later at that exact location. Weird.

PAPERS

01.

IMMERSIVE VIRTUAL ENVIRONMENT IN DESIGN EDUCATION:

A situated model of the learning process

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ABSTRACT:

The products of architectural design differ from other designed artifacts due to the fact that buildings are *environments*, rather than *objects*. Built environments surround the user and are dynamically perceived by all senses. Yet, in the course of Architectural Education, the spatial perception of students is often restricted to the use of representational objects such as models and scaled drawings, thereby limiting the students' ability to acquire the proper design knowledge and skills. We argue that Immersive Virtual Environments (IVEs) may potentially overcome this limitation by affording students virtual "presence" in their un-built environments, offering them a better comprehension of their designs, thereby facilitating the architectural learning process. To assess the impact of IVEs on the architectural learning process, compared to conventional architectural learning environments, we developed a methodology comprised of measurable Knowledge Construction Activities (KCAs). It was applied to an architectural design studio course, which was alternately held in an IVE and in a conventional Studio classroom. The course's learning sessions were observed and recorded. Protocol and Design analysis were used to glean the learning environment's influence on students' KCAs. It revealed that IVE enhances corporal sensations, emphasizing their contribution to perceptual skill improvement, leading us to conclude that IVEs can serve as an important tool for enhancing the educational learning process of architecture students.

Summary: This paper investigates the effects of the learning environment on the performance of architecture students, as measured through a model of knowledge construction activities that occur during an architectural learning session. Our findings suggest that IVE enhances learning activities and facilitates knowledge acquisition of architecture students.

Key words: Immersion; Design education; Perception; Virtual learning environment; Knowledge Construction Activities.

1. INTRODUCTION

Design education is predicated on the project-based approach, where students learn by designing some hypothetical artifact in increasing degrees of complexity. Since the actual products are typically too large or expensive to be executed in reality, students interact with a representation of the artifact rather than with the product itself. While this method is suitable for many types of engineered or designed artifacts, it does not work well for architecture: buildings differ from other designed products due to the fact that they are *environments*, rather than *objects*. Since built environments surround the user and are dynamically perceived by all senses, scale models or drawings do not fully convey to the students the real essence of their designed artifacts, thus limit their acquisition of design knowledge.

The research described here argues that this limitation may be overcome through utilization of Immersive Virtual Environments (IVEs), which afford the students real-scale virtual 'presence' in their un-built environments, thus offering them a better comprehension of their designs.

We claim that in order to fully understand the knowledge acquisition process that takes place at the studio, the effect of the *learning environment* itself upon the *learning process* must be taken into consideration. We suggest that the studio's physical and social settings should be considered inseparable from the design activity, forming a joint model of the learning process (Figure 1). Hence, the learning process, or 'Telos' [25], is the product of Knowledge Construction Activities (KCAs) accomplished by the student during the studio course. As KCAs can be described, quantified and assessed as units [43], it is argued they can serve as measures for evaluating the student's progress within different learning environments. This paper details the KCAs that occur during an architectural crit, and the effect of the learning environment on the students' performance.

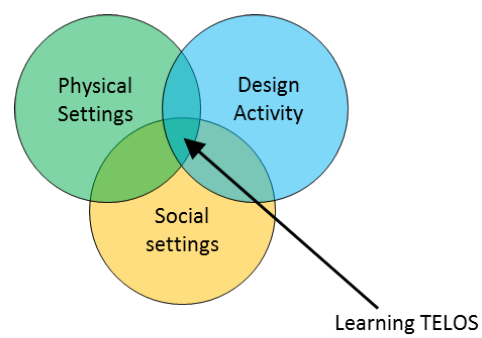

Figure 1: The architectural learning Telos'

1.1 Immersion

Virtual immersion's grand aim, as phrased by Slater et al [41], is to transcend the 'glass barrier' between a digital representation and the user, in order to achieve a sense of 'being' within the represented environment. This sensation is achieved via higher correspondence between human body movements and sensory feedback received from the computed display, at highly rich and vivid quality [42,44]. Researchers identified several degrees of immersion, differentiated from one another in the way users experience their 'presence' in the virtual space [41], and in their levels of contribution to improved understanding and error exposure [4,6,23,45].

Several IVE's were examined as educational environments for architectural and urban design studies, outlining that IVEs can indeed promote learner engagement [5,7,8,11,26], support situated learning models, and create diverse learning directions [10,27]. These issues were addressed in relation to physical display conditions, such as the influence of screen size and tangible view [21,22,48], the learner's position in the classroom when using immersive technology [2], and IVE's level of support of the design process [35].

IVEs are currently utilized for the professional training of nurses, surgeons, sportsmen and soldiers [19,24,28,47]. They enable trainees to develop a personal model of behavior when handling complex environments without endangering human life, improving performance and reducing costs. Likewise, since the architectural product can be fully experienced only post-construction, it is probable that utilization of immersive technologies for training Architecture students can be highly effective. As the Studio course's objective is to provide the student, whose design is never realized, with a conceptual model of the design process, IVE can expand this notion by affording a tangible sensation of the designed product that is as close as possible to reality.

1.2 The crit activity log

The primary method of teaching architectural design is the studio course, where the student is presented with a problem he has to "solve" by developing a personal design solution, under the guidance of one or more professional architects. The designs he develops are critiqued by the instructor in so-called design 'Crits'. By repeating this process several times, the student gains knowledge about the design process, as well as the tools and language of design. The studio crits serve as crucial points of encounter for knowledge construction, since that is where the student’s design product is mutually and simultaneously being perceived and conceptualized by the student, his instructor and peer students.

The crit structure and similar learning models have been thoroughly described in relevant literature, outlining their various communication and knowledge transmission opportunities [16,18,33,34,37,38]. According to Schön, the dialogue taking place during crit sessions consists of a descriptive part presented by the student, followed by explorative processes and the creation of understanding models. Figure 2 depicts a model of these activities.

The model distinguishes between two sequential processes that occur during the design activity at the time the design problem is being presented: (a) explorative processes, which include perceptual and reflective operations that are dynamic in nature; followed by (b) rationalizing processes, which can be described as the building of understanding models from what was perceived and conceptualized.

We claim that the crit's uniqueness, compared to other learning models, lies in the fact that each occurrence is, in fact, a one-time event, which significantly influences the 'Telos' of the student. Thus, the crit activities model may serve as a basis for the examination of different crit settings. As the crit activity is inseparable from its social settings, it is therefore important to view this model within the context of all crit participants, each of whom may perceive the design product differently, according to their levels of knowledge and abilities.

1.3 Perception in action

When design activity is considered as an exploratory search, one must consider how and what is perceived during this process. Most of the literature addressing the design process emphasizes the reflective thinking activity, whereas perception is seen as a passive experience [3,15,17,37,39,40]. Instead, we argue that the perceptual activity is a crucial element in the process of design and architectural education, due to the fact that the manner in which the architect perceives the proposed building helps him understand how it will be

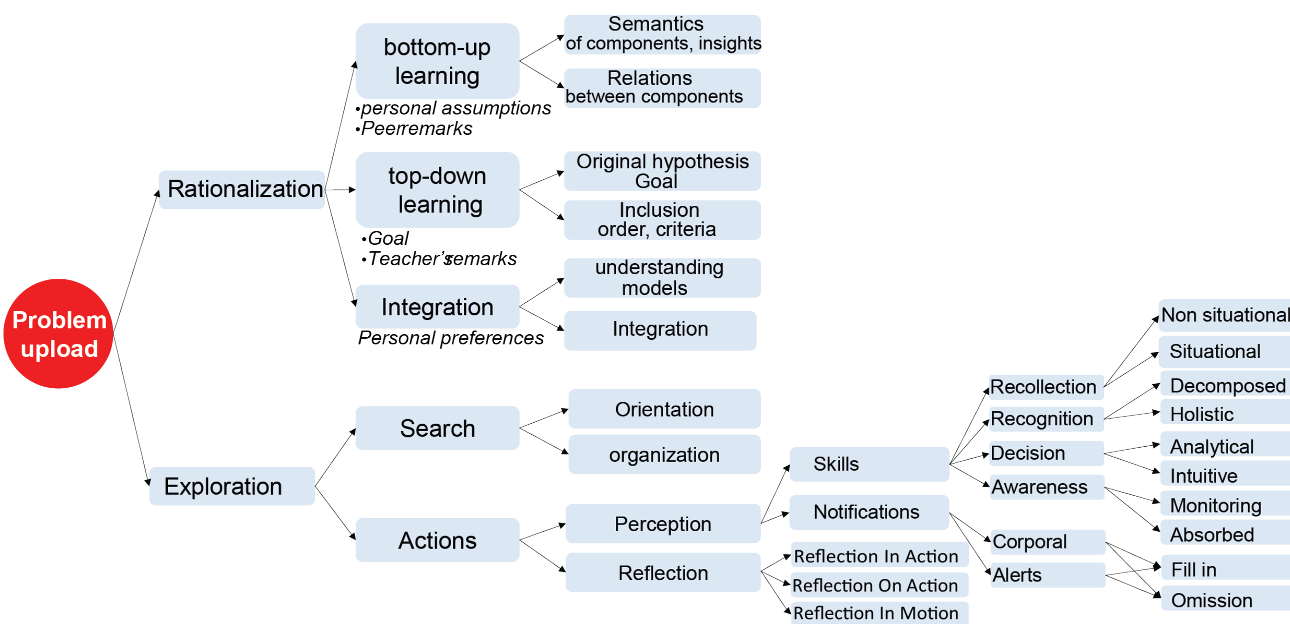

Figure 2: Design activities model

perceived and used by others, thus influencing the reflection and evaluation of his own decisions. Hence, perception is not a passive activity but rather a dynamic quality of experiencing the built environment that consists of the relationship between the designer and the subject in view [1,12,13,29].

The notion of perception has been described as an active phenomenon achieved through the interaction between the individual's complete embodiment experience and the environment [31,36]. Similarly, we claim that when the proposed design product is being perceived, both the learning environment and the representational tools in use affect the student's perceptual activity, thus fulfill a significant role in constructing his 'Telos'.

1.4 Perceptual processes

"We perceive not time, but processes, changes, sequences" (Gibson, 1986, pp12).

Gibson relates to the environment as the cause of change and transformable processes in human perception. He refers to the perceptual activity as an acquired skill which consists of an array of stimuli that generate recognition of 'unknown' contextual saliences. In time, some of the perceived features become 'known' and their role as stimulators decreases. Moreover, when a picture is static, the viewer perceives information in an *analytic* manner, as an unchanging surface whose boundaries he can clearly view or feel, whereas other senses are filled-in by relying upon prior experience [12-14]. There exists nevertheless, a correspondence between the represented content and the perceiver, which needs to be processed to be comprehensible [46]. A similar approach in linguistic skill acquisition uses the notion of perceptual recognition of differences and similarities within a text to create an acquired scale of expertise [9]. Figure 3 describes the perceptual process, depicting its different phases. Since we consider this an active process, it is possible to see that the environment serves as a stimulator which the viewer detects and recognizes according to his personal abilities. Hence, convergence into a wholistic comprehensive model will strongly rely on these abilities and the mode they were percieved (full embodied perception of a dynamic context, or a static surface such as a picture, or a drawing).

Noë and O'Ragen relate to a set of 'notifications' received by the embodied experience during a perceptual activity. *'Corporal'* and *'Alerts'* are notifications received while sensing the environment and affect behavior. This capacity is greatly influenced by the field of view, the observer's motion or changes of the viewed object. High corporality is achieved by using the body in the act of perception, such as moving the head or a limb for gaining better input [29-32].

In summary, architectural design education is responsible for the construction the relationship between man and the built environment. This connection is highly complicated and is revealed to the student during the learning process itself. IVE, we claim, can facilitate and bridge this gap by enabling the learner to experience his design in full-scale as a built environment. The following details how the use of IVE affects the learning activities and architectural 'Telos' construction.

2. KCA APPROACH

Our aim is to understand the learning environment's impact on the architectural 'Telos'. The approach taken considers 'Telos' as consisting of units of measurable Knowledge Construction Activities (KCAs), which represent the student's decisions as expressed in his design project and presented at the crit sessions [43].

Each KCA contains a pattern of decisions and data derived from three domains: the social setting, the physical setting, and the design processes that were performed during the crit (figure 4). The Physical setting domain contains all the conditions that were used by the student when performing the design action. They include the physical conditions of the classroom, the format of the representation (static pictures and

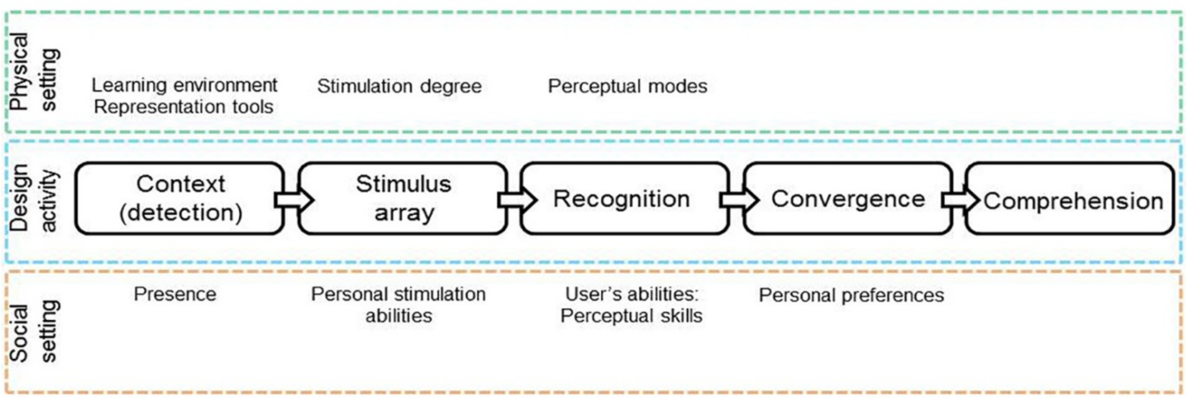

Figure 3: Perceptual Process

drawings or three dimensional models), and mode of observation (static or dynamic navigation) that were used at the crit session. It also includes the received view (scaled and bounded view or full-scale and immersed view). The Social setting domain contains all the participants' comments during the crit session. The Design Activity domain contains the actions performed during the crit, such as the student's perceptual activities (analytical or analogical), reflective thinking and reasoning.

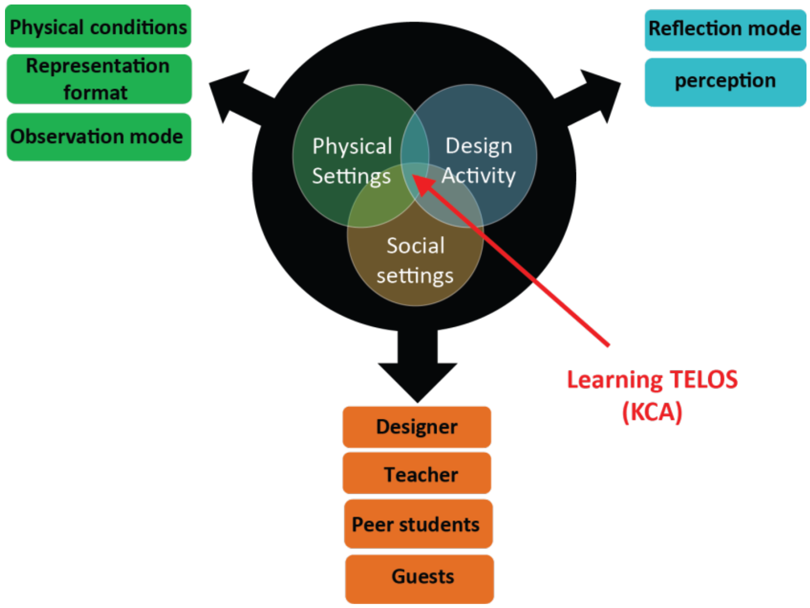

Figure 4: KCA's Domains

We categorize two types of KCAs patterns: a *Strategic* activity pattern, in which the action relates to a change in the student's approach and theory that are used during the design process, and a *Methodic* pattern, which defines a change in the designed form. Figure 5 illustrates the situated data which is formed in one decision.

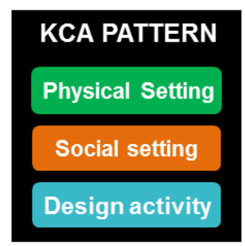

Figure 5: KCA Pattern

We distinguish between *analytical* perception mode of a (mostly) static and bounded scaled representation (like a model or scale drawing), and *analogical* perception mode of full-scale, immersed, dynamic, and boundary-less representation received at the IVE. By adapting Dreyfuss & Dreyfuss (1980) scale of skill stages to design perceptual activities, we assessed the learning environment's contribution to perceptual skill improvement.

Protocol analysis was used for retrieving IVE affordances of analytical and analogical perception modes. The coding scheme outlined/extracted the expressions that related to the KCAs domains and semantics that originated from participants' comments and professional language.

Protocol coding system:

(a) Coding scheme:

- Social setting: student designer, instructor, peer students, guests.
- Physical Settings: design format, dynamic navigation mode (using IVE), personal navigation (using a personal laptop)
- Design activity: analogical perception, analytical perception, existing environment (perceiving the real site)
- Main ideas: student's decisions as presented during the Crit.

(b) Codes semantics:

- Analogical perception code relates to expressions that describe a sense of feeling towards the designed space, expressed by 'embodied' notifications.
- Analytical perception code relates to measures and sensation-less expressions regarding space.

This methodology was utilized to account for the patterns of activity taken in the learning environment, while using their situated data to extrapolate the perceptual actions activated by the students that lead to certain actions and influenced the 'Telos' construction.

3. CASE STUDY

The research observed a fourth-year architectural design Studio Course at the Faculty of Architecture and Town Planning at the Technion, which used an IVE as part of the educational environment. Crit sessions were held alternately in the Studio classroom and the IVE Visual Laboratory (VisLab) (Figure 6). The IVE consists of a windowless classroom, equipped with a 2.4x7.0m screen with a 75° edge-free field of view. Dynamic navigation was afforded by use of body movement tracking cameras or wand navigation instrument, allowing for single user control and a shared experience for up to 20 viewers.

Four design projects were followed by means of observations, crit recordings and documentations of the design products. Due to the small number of participants, the scope of the results is limited and should be considered preliminary, to be re-evaluated through more extensive experiments.

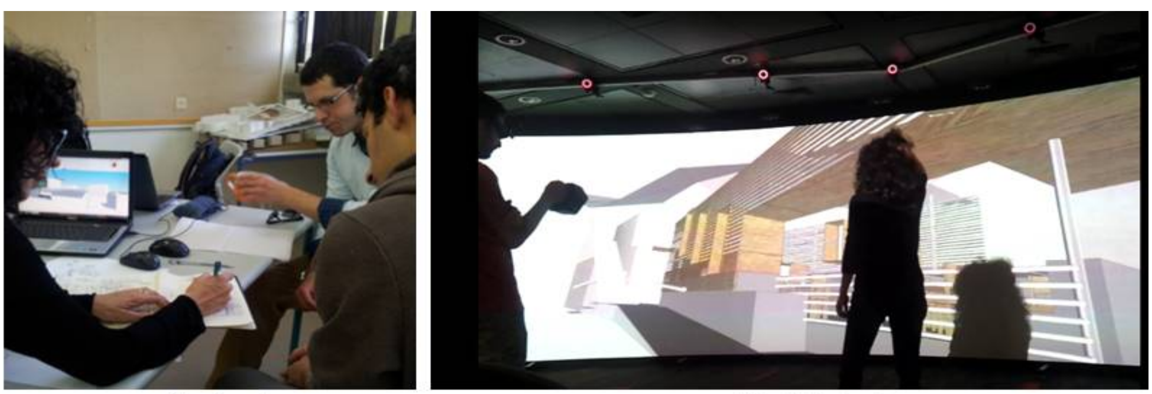

Figure 6: Crit's physical Settings: The studio classroom and the immersive visual laboratory at the faculty of Architecture and town planning, Technion

The students' design products were documented and analyzed in relation to KCA's three domains and the occurrences of major decisions. Analysis elaborated the different KCA patterns achieved at each crit. These patterns were assessed quantitatively, determining their level of frequency during the course.

4. RESULTS

4.1 KCA Patterns

Table 1 illustrates diverse uses of the learning environment during the course. It shows that student B participated in two out of eight IVE crits, during the first and last course sessions, thus indicating that 'Telos' was mainly developed at the non-IVE studio setting. Students N&D attended seven IVE crits, mainly perceived static images and drawings of their own project, yet experienced dynamic navigation modes by viewing their peers' projects. Students O&L attended all crit sessions and started to use dynamic navigation mode at early stage of the course (the fifth lesson). Their design analysis outlined an occurrence of skill improvement after IVE crits. Student A presented two-dimensional pictures and drawings until the eighth crit session, where he dynamically navigated his three dimensional model in full-scale. During his post course interview he referred to that session as a critical turning point, claiming it was the first time he understood his idea. His 'Telos' assessment revealed a higher KCA frequency elaboration in the subsequent lesson. Since student A's design contained three paths that overlapped each other, he used dynamic navigation mode to understand what can be viewed in each path. Students N&D and O&L also used their "presence" in their design to gain better comprehension of what is viewed from the second floor.

Students	Crit Attendance	IVE crit	Studio crit	Dynamic navigation usage
O&L	100%	8	4	5
N&D	90%	7	3	2
A	72%	5	2	3
B	54%	2	4	1

Table 1: The learning environment usage

Table 2 details KCA's frequency in relation to the learning environment. It clearly exhibits higher frequency by students who used IVE crit, hence demonstrating this environment's ability to provide stimulation and promote further design activity.

students	IVE	Personal	Studio
O&L	70.37%	14.81%	14.81%
N&D	73.33%	10%	16.66%
A	70.833%	16.667%	12.5%
B	11.11%	27.77%	61.11%

Table 2: KCA frequency within the learning environment

4.2 Perception modes

Figure 7 presents protocol analysis of expressions used during IVE crits that are semantically related to Analogical and Analytical modes of perception and details the diverse use of these expressions by various speakers (instructor, student and peer students). It also provides a comparison between the four projects, clearly showing the IVE's contribution to shared perceptual activities achieved by observers other than the student designer, and distinguishing this type of IVE from other immersive environments where perceptual experience is personal.

4.3 Perceptual stimulators and notifications

An example of an Analogical perception mode experience during IVE crit at the VisLab, students O&L used dynamic navigation mode to observe their designed café and shelf system (Figure 8). They immediately commented that their design was claustrophobic. This reaction was also shared by the instructor and peer students. In the subsequent lesson, the students removed the central shelf system and explained that it "opened up the space".

Figure 8: An Analogical perception mode experience. Students O&L

Another example demonstrates a shared Analogical perception mode experience. Student A designed a three-path circulation system. During the IVE crit, the instructor and peer students commented that the designed paths are too narrow for both walking and a sitting bench. Other peer remarks related to the student's design of the entrance wall, commenting that it can cause someone to stumble and fall. This example emphasizes how IVE elicited comments by the crit attendees and initiated a shared construction of knowledge.

Post-course interviews were held with the students and their instructor, reflecting their personal impressions

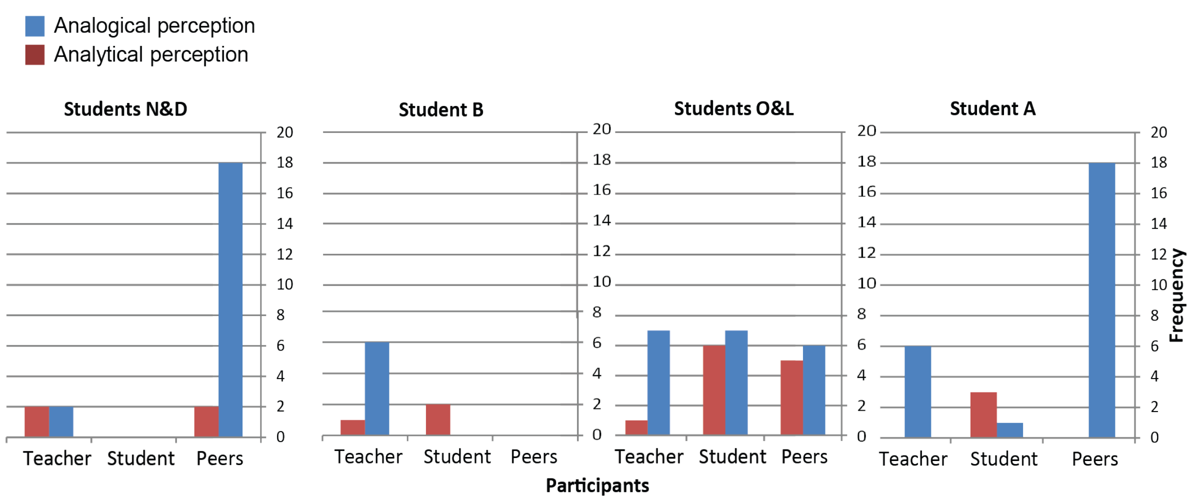

Figure 7: Perception modes occurrence using IVE

and experience, as the following exemplifies:

- *"Dynamic navigation (using IVE) enabled me to understand what a person sees and feels when using the design... At the VisLab, the space feels much more tangible, like a real space... so if I stand between the counter and the rail and it feels too narrow, I can feel it's true. When I use a personal computer, if I want to know whether a space feels too cramped, I will measure it".* (Student A interview)
- *"...for example, when you see a picture of a ceiling it is not the same as having a ceiling over your head. Your body responds to it...in a scaled representation the ability to perceive the distance between one line and another is limited"* (Student B interview, 2014)
- *"..it (IVE) emphasizes the sensation of the space, because it is (presented) in a larger format"* (students N&D interview, 2014)

Students' comments, like the above, reflected the IVE's affordance in providing a tangible, 'close-to-reality' and embodied perception opportunities, which promoted an analogic mode of perception and improved their understanding of how a person feels and acts in their designed environments.

5. CONCLUSIONS

This paper argued the notion of architectural knowledge as situated and constructed in direct relation to its physical and social settings, which strongly influence the design activity. The authors' assessment of this influence was afforded by using KCA units as a methodical framework for the examination of the learning 'Telos' and the effects of the learning environment on the student's performance.

Although this research was performed on a small group of students, it nevertheless provides positive evidence that IVE promotes diverse architectural learning 'Telos' of the student, by strengthening peer involvement and knowledge acquisition through improved feedback and reflective thinking opportunities. It also enables wider perceptual activities, previously left to imagination and prior experience.

The research observations show that utilization of IVE extends crit session duration due to exposure of many details and viewpoints unexposed by a static and pre-selected point of view. As such, IVE is significantly different from the studio settings in providing new perspectives for the student designer that enrich their stimulus array, thus facilitate exposure of contextual errors, saliences and new opportunities. As this environment provides a shared crit model and perceptual activities, it facilitates descriptive rationalization sections in the crit log.

Research analysis further reveals that IVE enhances *Analogical* perception activity by stimulating corporal sensations and expressions during dynamic navigation mode, emphasizing its contribution to improved comprehension of the design as a built environment.

Based on the above, the authors suggest that IVEs can serve as an important design evaluation tool and a unique educational environment for Architecture students, compatible with this profession's special needs.

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02.

Post-Fukushima 3D Virtual Collaboration and Communication for Active Learning.

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Abstract: In any task design it is important to consider its difficulty for the intended learners. Task designers such as school teachers and Higher Education practitioners need to provide tasks commensurate with the expected successful outcomes that will, it is anticipated, be developed by the learners. Task Fidelity is a useful indicator of the complexity of a task, and a cognitive determiner of Task Fidelity is immersion or flow. The aim of this research therefore is to determine quantitative metrics of tasks and learner solutions by calculating task complexity and learner immersion. Implementating increasingly complex 3D virtual world telerobotic operations together with the collaborative programming of LEGO Mindstorms robots by remotely located students in Japan and UK to solve realistic problems allows researchers to acquire data of circuit task complexity, programmed robot task complexity, and learner immersion. Students participating in international 3D virtual tele-collaboration challenges utilizing multi-modal communication tools within a simulated disaster zone will consequently enable educators to quantify the impact of active learning in 3D virtual worlds.

One Sentence Summary: Robot-mediated interactions in post-Fukushima 3D virtual world scenarios result in quantifiable tasks of measurable educational value.

Introduction: The research described in this paper engages Japanese undergraduate students and UK high school pupils in actively participating in international collaborative tasks which integrate the design, construction and programming of basic robots in both the real world and unique virtual world simulations. It is proposed that students will be incentivized to use the knowledge gained in their theoretical technology courses to pragmatically solve challenges of increasing task complexity when engaged in meaningful, task-oriented collaboration and communication. The on-going project is guided by our research hypothesis: Implementing quantifiable robot-mediated interactions in 3D virtual worlds significantly increases participants' declarative, procedural and meta-cognitive knowledge.

The paper begins with a justification for more active learning scenarios in education, and that such contexts must consider task design as central to any pedagogical implementation. The paper then justifies the use of 3D virtual worlds to promote active learning and goes on to explain the rationale for using LEGO Mindstorms robots as the stimulus for robot-mediated interactions. Task complexity and immersion are then outlined as metrics for designing tasks that necessitate interactions between learners within the context of collaboratively programming robots. that, two 3D virtual world scenarios are illustrated. Finally, the data collected from tasks within the 3D virtual worlds to determine active learning and immersion are summarized.

Active learning: Anderson *et al.* [1] propose a hierarchy of knowledge consisting of factual knowledge (relating to a specific discipline), procedural knowledge (techniques and procedures), declarative knowledge (relationship between concepts) and meta-cognitive knowledge (knowledge of demands, strategies and one's limitations). However, Hase [2] believes more is required: "The acquisition of knowledge and skills does not necessarily constitute learning. The latter occurs when the learner connects the knowledge or skill to previous experience, integrates it fully in terms of value, and is able to actively use it in meaningful and even novel ways" (p.2). Experts in neuroscience additionally argue for more 'active learning' through experience [3]. A pedagogical approach is therefore required which encourages learner exploration, development of procedural knowledge, iterative, recursive and logical thinking, structured task breakdown, and dealing with abstractions. The literature refers to such cognitive development as Computational Thinking [4]. A practical implementation for such active, experiential and multi-disciplinary learning is for students to consider, analyze, solve and make personal meaning from engaging problems. Collaborative problem-solving promotes communication involving creative and interpretive meaning-making, analysis and reflective judgement [5].

Unfortunately, Learning Science researchers have posited that Japan's assessment-focused education culture, though highly rated in OECD and PISA tests, negatively impacts upon learners' capabilities to progress from static declarative knowledge to active procedural knowledge and, subsequently, to meta-cognitive knowledge [6]. In an attempt to develop students' knowledge capabilities, we have developed a simulation of the Fukushima nuclear power plant in a Unity3D virtual space, with a prior Training Area built in an OpenSim 3D virtual space, for Japanese students to collaborate with UK students. We considered this scenario to be highly motivating for Japanese students because of its national proximity and immediate impact on themselves, their families or their friends, and for UK students because of the international interest the Fukushima accident generated, especially in light of similar incidents in recent history and also because of the UK's current review of its strategy towards replacing its ageing nuclear power infrastructure [7].

An illustrative video is available to view on our companion website at http://www.mvallance.net

The Fukushima context: The Fukushima Daiichi nuclear power plant disaster of March 2011 revealed much about Japan's lack of preparedness for nuclear accidents. Despite the brave efforts of its labor force leading up to, and in the aftermath of, the reactor explosions, it became apparent that coordination and communication were disorganized. Four reactors at Fukushima exploded and radioactivity was released to the atmosphere. One of the most surprising technology related episodes during the post-disaster efforts was Japan's lack of robots to assist with the recovery operations. Japan, a robotics-friendly nation with the world's highest levels of automation, had to count on foreign assistance. iRobot USA engineers trained Japanese operators the following week, yet it took three weeks for the plant operators (TEPCO) to authorize their use. An anonymous worker blogged daily about the experiences of using the donated iRobots to assist the efforts of stabilizing the damaged reactors. He highlighted, often with tragic humor, the barriers to working effectively: inept supervisors, demanding schedules, lack of resources, poor communication infrastructure, neglect of safety, supervisors' instructions to ignore dosimeter alarms, lack of coordination, and delays in deploying robots [8].

Justification of LEGO Mindstorms robots: An approach is required which encourages exploration, development of procedural knowledge, iterative, recursive and logical thinking, structured task breakdown, and dealing with abstraction; in other words, Computational Thinking

[4]. An instructivist pedagogy does not support such an approach, so an alternative has to be sought. Prior successful projects have involved simulation and robotics. For instance, beginner programming concepts can be introduced and experienced using the graphical LEGO Mindstorms software which has been shown to support programming through its drag-and-drop graphical user interface [9].

Closed and highly defined tasks provide the necessary comparability and empirical data to determine the success of task completion [10]. To satisfy these criteria, the programming of a robot to navigate mazes of measurable complexity can be adopted [11]. Research can be designed to observe students communicating in a 3D virtual world when programming of a robot to follow distinct challenges which, in turn, results in tangible and quantifiably measured outcomes.

Consequently, LEGO Mindstorms robot hardware and software (Figure 1) are used in our research as tools to mediate the communication of the students (Figure 2). Our research has been designed to collate data of students collaborating in 3D virtual worlds to program LEGO robots to successfully navigate mazes from start to completion in both the physical world and simultaneously within the 3D virtual spaces. This is implemented by students remotely located in Japan and UK who: (i) design circuits that necessitate the use of robot maneuvers and sensors; and (ii) collaborate in a virtual world to solve pre-determined tasks. The task solutions necessitate the use of programming skills, collaboration, communication, and higher-level cognitive processes. It is posited that these experiences lead to personal strategies for teamwork, planning, organizing, applying, analyzing, creating and reflection.

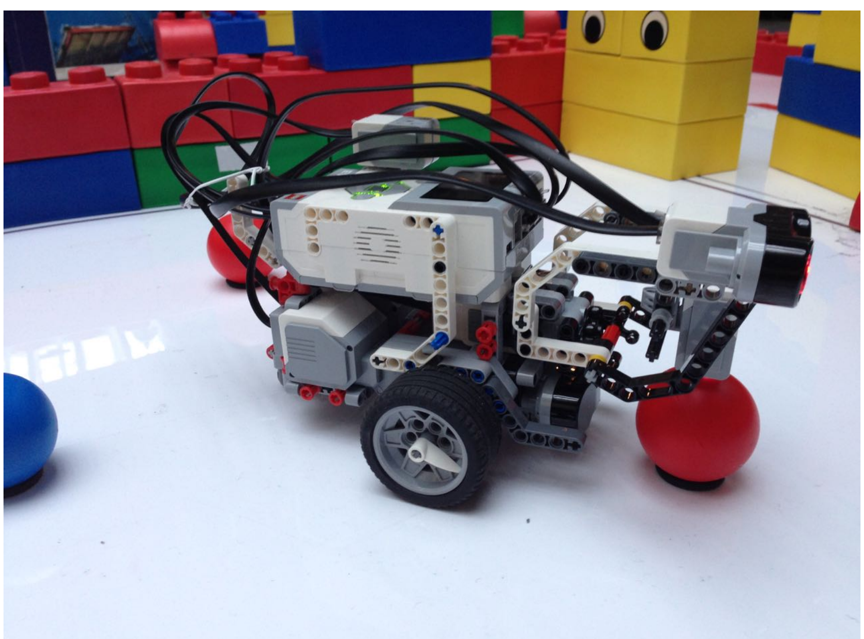

Figure 1. LEGO Mindstorms EV3 robot.

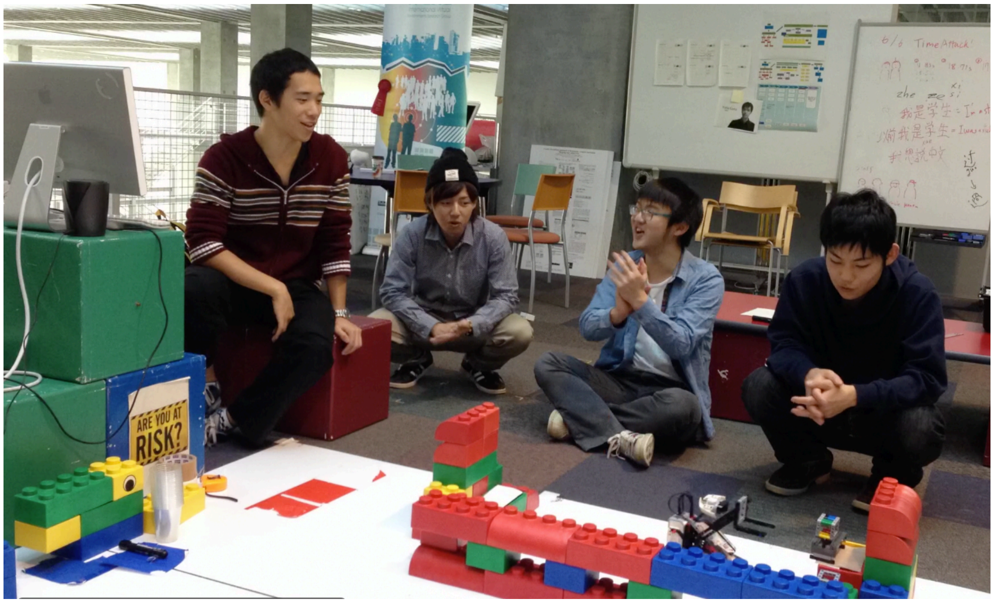

Figure 2. Japanese students solving a circuit problem.

Justification of 3D virtual worlds: If learning is considered to be a process whereby knowledge is created through the transformation of experience, education requires a re-consideration of how, what, when, and where we learn. Learners' virtual experiences, their use of multiple media, the transactions and activities between peers, and the facilitation of learner control between them can support deeper reflection upon the practices of learning and teaching which arguably leads to wider opportunities for experiential learning [11].

As LEGO EV3 robot programming components can be used to quantify task complexity and thus iteratively increase the challenges given to high school and under-graduate university students, the 3D virtual simulation provides interesting, engaging, realistic yet safe contexts where robots are ordinarily utilized; i.e. disaster recovery situations. A virtual simulation allows remotely located students to enter as avatars to communicate and collaborate with other students. Data within world can also be captured for analysis. By actively participating in international collaboration challenges, which include controlling basic robots within a simulated disaster zone, it is anticipated that students will develop programming, design and communication skills. In future, the developed technology can be transferred to simulate other disaster scenarios.

Metrics: The acceptance of 3D virtual worlds in education requires valid metrics of learning. As a consequence of our implementations we are developing an evidence-based framework of tasks of measurable complexity in virtual worlds. This is undertaken by collecting data of collaboration: (i) capturing students' procedural processes as they work through the task solution; and (ii) capturing students' learning reflections during and after completion of tasks.

As stated, our project encourages students to communicate in a virtual world when programming a robot to solve pre-determined tasks. The students' aim is to effectively communicate solutions to problems that involve the programming of a LEGO robot to follow the specified circuits. This is undertaken by (i) designing circuits which necessitate the use of robot maneuvers and sensors; and (ii) experiencing collaboration in a virtual world with other, remotely located, students. However, to give meaning to the students' experiences over a series of task challenges, we need to quantify each task's complexity. Common metrics allow for benchmarking within a particular domain. When discussing robots that undertake specific maneuvers, some researchers provide a common metric labeled as Task Complexity, where tasks are defined as physical action units that are undertaken by a robot, and the designation 'complexity' is used to characterize the intricate parts of a task. Murphy and Schreckenghost [12] conducted a meta-analysis of twenty-nine papers that proposed metrics for human-robot interaction (HRI). Forty-two metrics in total were determined. They found though that HRI metrics were often not measured directly, but most often were 'inferred' through observation. Although the paper identified proposed HRI metrics, it was recognized that they "have no functional, or generizable, mechanism for measuring that feature" [*ibid*]. After conducting a review of the literature, Vallance *et al.* determined that a gap in the research existed so proposed a new metric for robot-mediated tasks, termed Task Fidelity [7, 8].

Task Fidelity. Task Fidelity is defined as an indicator of the complexity of the circuit compared with the complexity of the program to complete the circuit. For instance, in designing the task challenge, Circuit Task Complexity (CTC) equals the number of directions + number of maneuvers + number of sensors + number of obstacles.

$$CTC = \Sigma\ (d + m + s + o)$$

For example, if a robot has to maneuver past 2 obstacles in order to reach its target, the number of directions to be programmed can be 4, the number of maneuvers is 3, and the number of sensors is 2 (i.e. two touch sensors), then $CTC = \Sigma\ (4 + 3 + 2 + 2) = 11$

We then modified our task complexity to be determined by the LEGO Mindstorms EV3 program solution rather than the circuit to be navigated. We call this Robot Task Complexity (RTC), which is measured as:

$$RTC = \Sigma\ M_{v_1} + \Sigma\ S_{v_2} + \Sigma\ SW + \Sigma\ L_{v_3}$$

where M = number of moves (direction and turn); S = number of sensors; SW = number of switches; L = number of loops; v = number of decisions required by the user for each programmable block ($v_1 = 6$, $v_2 = 5$, $v_3 = 2$)

In order to compare the data from all tasks, for the Circuit Task Complexity values we took the maximum CTC value of all our tasks and divided it into each task's CTC value. Similarly, for the Robot Task Complexity values we took the maximum RTC value and divided it into each RTC value. All values are thus represented between 0 and 1. As a result, the complexity of the task can be quantified by a new metric which we term Task Fidelity; where Task Fidelity = Circuit Task Complexity - Robot Task Complexity (TF = CTC – RTC). A more detailed development of Task Fidelity contextualized by our research has been published in Vallance *et al.* [7, 8].

Immersion. Over the course of our research, five virtual spaces have been designed and utilized: Second Life, OpenSim, OpenQwaq, Unity 3D and Unity 3D with Oculus Rift. In each virtual world participants from Japan, UK and USA have been engaged in remote collaborations to solve problem-based tasks requiring the programming and manouvering of virtual robots and real-world LEGO Mindstorms robots. Robot Mediated Interactions are analyzed to determine robot task complexity, student learning and task immersion. We have determined that for effective active learning involving 3D virtual worlds specifically focusing upon the development of beginner programming knowledge, the challenge is for educators to design tasks of zero (or close to zero) Task Fidelity and for students to become fully immersed within the tasks. Task Fidelity is a useful indicator of the complexity of a task, and a cognitive determiner of Task Fidelity is immersion (or flow). To calculate immersion, we utilized Pearce *et al.'s* [13] flow criteria of task challenge and skill: "Amongst the various studies researching flow, an on-going issue has been to find a method for measuring flow independently from the positive states of consciousness (such as enjoyment, concentration, control, lack of self-consciousness, lack of distraction). One solution has been to use a measure of the balance between the challenge of an activity and the participant's perception of their skill to carry out that activity" (p.250).

In order to capture this data immediately after the completion of a task and while still in communication with their virtual collaborators in the virtual world, the students reported on the task's challenge and their skill in attempting the task. For 'challenge' they had to report whether they considered the task difficult, demanding, manageable or easy. For 'skill' they had to report whether they considered their ability to undertake the task as hopeless, reasonable, competent or masterful. Once the task had been completed, students logged out of the virtual world and a general discussion of the task process and its outcome was held locally with the researchers. Immersion is then graphically illustrated using Carli *et al.'s* [14] Eight Channel Model of Flow: arousal, flow, control, boredom, relaxation, apathy, worry, and anxiety (Figure 10).

This paper refers to only the Japan and UK collaborations. Tasks are conducted in two scenarios.

Scenario 1. A virtual Fukushima nuclear power plant. Before entering our virtual Fukushima, students undertake tasks in the Training Area (Figure 3) developed using the OpenSim platform: an open source multi-platform, multi-user 3D application server. Our learner-centered design approach enabled a number of innovative tools to be created and customized by the students in OpenSim: for instance, the ability to move a graphical representation of the LEGO robot object and leave a trace of the circuit in-world. Also, media objects in-world can display live streamed video from the lab in Japan (using the online UStream service) and also from an iPhone attached to the front of the LEGO robot (using the Bambuser iPhone App). Virtual noticeboards can be updated with text and images to aid communication. Although programming is mostly undertaken using the Mindstorms NXT and EV3 software, a LabView VI has been developed to enable communication directly between an in-world prim and the physical LEGO robot [8]. Some tasks involved Japanese students collaborating with other remotely located Japanese students and some with Japanese students collaborating with UK students. Tasks included maneuvering around obstacles using distance and turn commands, using touch sensors to find ways around obstacles, constructing a bridge and using touch sensors to move over obstacles, using light sensors to avoid obstacles, using sensors to locate items, and manipulating the telerobotic controls to virtually maneuver our LEGO robot within the virtual space as part of 'search and rescue' simulations. Communication between students required the use of virtual world tools such as text panes, voice, live video streaming of respective real-world labs, and 3D presentation boards where Mindstorms program images were deposited. Avatars in-world enabled students to remotely maneuver a real-world robot. Moreover, a LEAP Motion controller was set up for hands-free remote maneuvering of the EV3 robot; as shown in Figure 4.

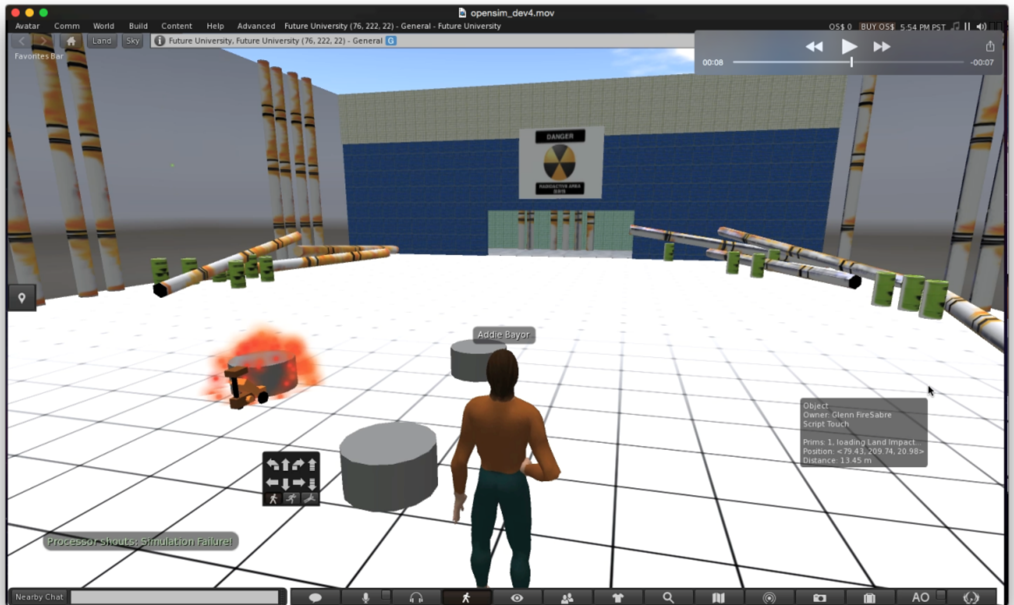

Figure 3. OpenSim Training Area of avatar maneuvering virtual robot.

Figure 4. LEAP Motion controller being used for remote maneuvering of EV3 robot via OpenSim Training Area.

We created a virtual Fukushima nuclear plant using the Unity 3D application and accessible via a web browser (Figure 5). In this space we can view reactors plus four cooling towers. We are currently programming a virtual robot to move within the Fukushima space and its maneuvers replicated in our real-world lab by a LEGO Mindstorms robot. As the project matures we would like children and adults to gain hands-on experience moving around our simulated virtual

Fukushima space and observe a physical robot simultaneously moving at a remote location (e.g. in a scaled mock-up of a hazardous building such as the reactor). It is anticipated that such user-accessible simulations with citizens controlling the virtual robot will create an awareness and understanding of disaster recovery, and not simply rely upon retrospective information from unprepared experts. As well as capturing data for analysis of cognitive processes, we also aim to familiarize students and the public with the complexities of nuclear power; given that there is much confusion about the situation at present in Japan [8].

Compared to the first phase of this project, our current research includes an improved interface to control the virtual robot inside the Unity 3D virtual world and the LEGO EV3 robot in real world. The key to this new design is to present a friendly control system for the robot that will encourage both new and experienced users. This design also provides a simulation of operating robots in a hazardous environment. A virtual robot that imitates a real- world LEGO EV3 robot can be used in such operations. This requires updates to the programming for controlling the robot in both real and virtual worlds; which can currently be implemented in the OpenSim Training Area. A Control Station with 3-D user-interface and a single video screen for ease-of-operation provides real-time feedback to the user. In addition, the disaster themed building with several types of debris are interactive assets that provide feedback (such as an explosion) should the virtual world robot collide with them.

Figure 5. A bird's-eye view of our virtual Fukushima.

Scenario 2: Recovering radioactive bins using Oculus Rift. To additionally engage our learners in the active design and construction of their learning environment both in the 3D space and the real world lab, we commissioned a consultant Unity programmer to initiate the design of an abandoned factory as our virtual space. The rationale is to combine a 3D simulation space for real world collaboration; in our case we are teaching the programming of robots contextualized by simulating a robot navigating in a restricted area. We then present participants with the following scenario:

> Four children have been admitted to hospital with apparent radiation sickness. They were playing in the old abandoned factory complex belonging to NEPCo (Nuclear Energy Production Company). Upon inspection, the factory area recorded a radiation value of 4.00 Sv/h. This measurement is the same value as the Fukushima Reactor 1. Note that a dose of 0.75 Sv/h can be enough to induce radiation sickness. Therefore, it seems it is too dangerous to enter the factory complex. It is estimated there are 5 radioactive bins within the complex. We are not sure where the radioactive bins are located and do not yet know why they have been dumped in the old factory complex. Your mission is to maneuver the Unity robot and drone, locate the 5 radioactive bins, and return them to the designated safe area. Be careful! One wrong move can cause an explosion ... and disaster!

Students can maneuver the virtual robot, using the built-in controller, to pick up the radioactive bins. A birds-eye view is offered via a virtual drone which can be maneuvered over the abandoned factory, seeking out the location of the radioactive bins (Figures 6, 7, 8). The project has also been developed to be viewable via the Oculus Rift (Figure 9) and utilizing the hands-free Leap Motion controller. Data is currently being collected as students in Japan participate in tasks requiring collaboration and communication. Also, a comparison between the two scenarios is being investigated.

Figure 6. A bird's-eye view of the abandoned factory via our virtual drone.

Figure 7. User's view when maneuvering virtual robot to pick up radioactive bins.

Figure 8. Disaster occurs if a radioactive bin is dropped.

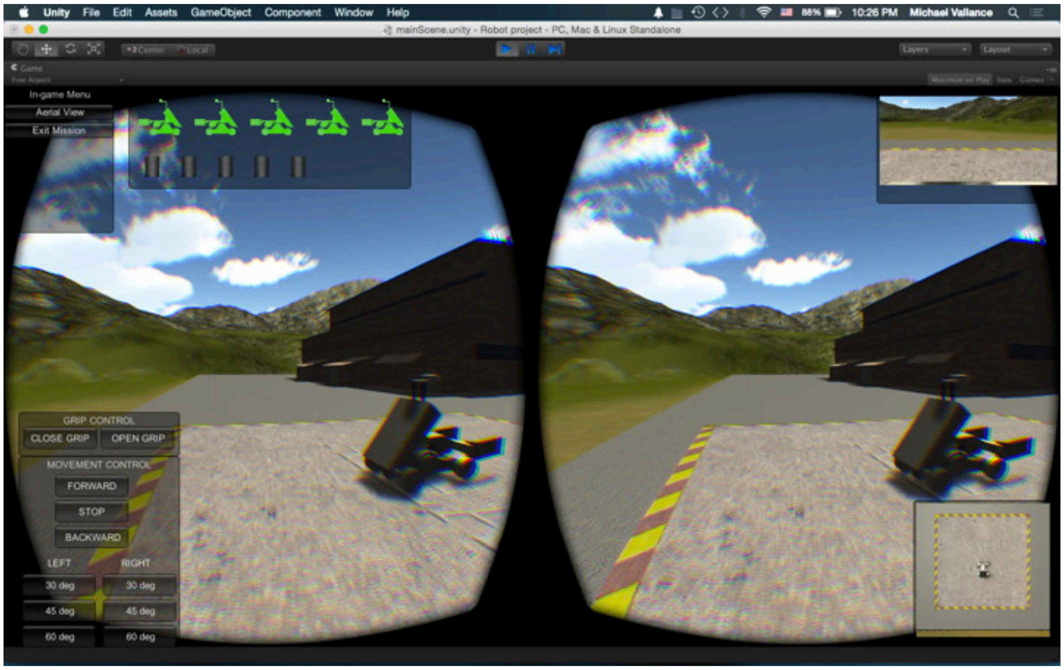

Figure 9. Robot and controls view when using the Oculus Rift.

Results: In this project, the participants have been undergraduate students studying Media Architecture in a Systems Information Science focused Japanese university (N=6) and A-level students in UK studying science-based subjects (N=10). Of the 16 participant students 2 were female, 14 were male, all are aged between 17 and 19, and none had prior experience working with the project's technologies.

A total of 53 robot tasks have been undertaken to date. Task designs and learning analysis are beyond the scope of this paper but are detailed in our International Journal of Learning Technology paper [7].

We have calculated the immersion of students within each task (Figure 10). Given that data from Tasks T10 and T28 were considered 'optimal tasks' [7] we revisited the additional data and increased the flow metrics; Tasks T10 and T28 are within Carli *et al.*'s [14] immersion quadrant tagged as 'arousal' and 'control' respectively. Tasks which fall within a state of 'flow' are tasks T5, T6, T7, T11, T14, T17, T18, T21, T22, T30, T35, T39 and latterly T47, T46, T41, T53.

Combining the observations of Task Fidelity and immersivity suggest that tasks T5, T6, T7, T11, T14, T17, T18, T21, T22, T30, T35, T39 would be considered the most successful tasks when students are engaged in robot-mediated interactions. Looking back at the task details, a variety of sensors were used in these tasks. As the tasks became more complex, according to our Robot Task Complexity criteria, the students indicated that even though the tasks were considered 'demanding' they deemed their skills to be 'competent' thereby indicating some degree of development. However, in later tasks the students revealed that as the level of challenge increased (from 'manageable' to 'difficult'), their skill level in attempting to seek successful outcomes decreased (from 'competent' to 'reasonable'). Looking at the task communication transcripts and screen captures, it appeared that the students had to utilize different procedural knowledge involving, for instance, programming a touch sensor to coordinate with a motor action. These latter tasks required students to 'analyze' and 'create' unique solutions based upon their prior task experiences and were thus deemed most challenging. The increased task complexity necessitated a higher level of programing skill incorporating sensor variables and loops. Even though students' post-task reflection data revealed that they found sensor related tasks difficult, being immersed in a task led to more 'active learning' and, in turn, led to greater student success [7].

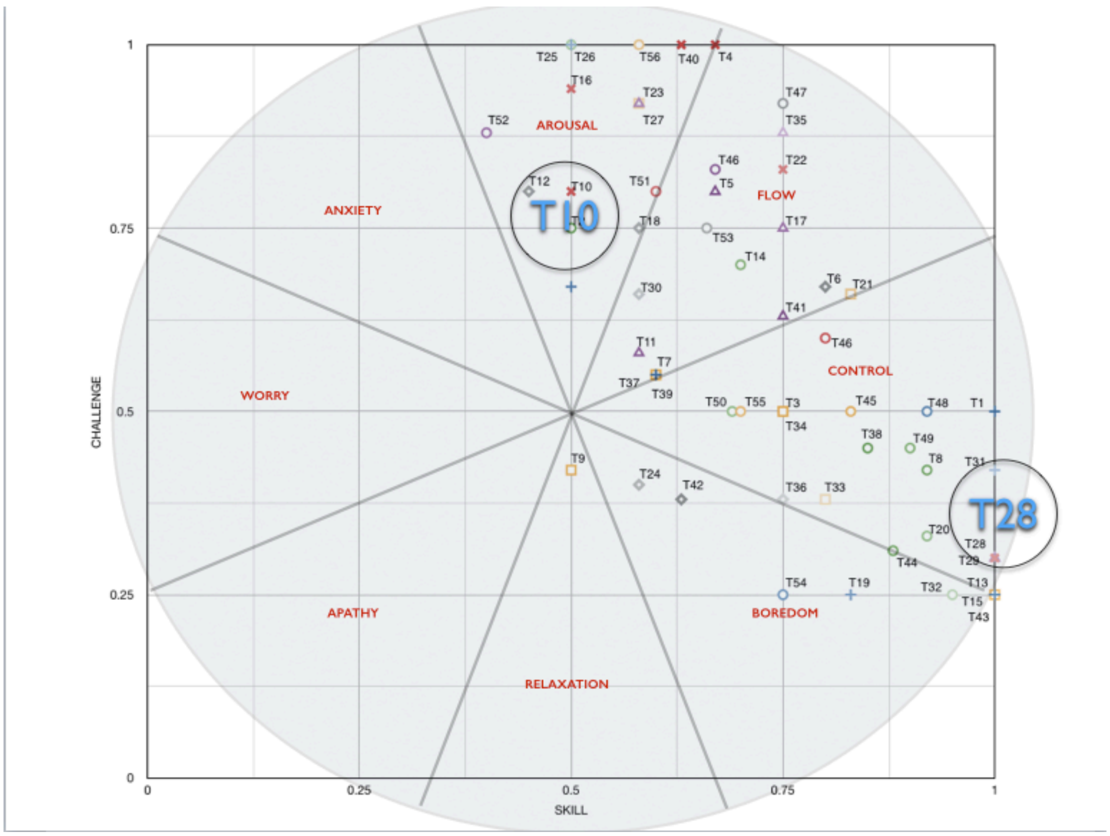

Figure 10. Immersion data.

Conclusion: Virtual worlds, simulations and subsequent student communication and collaborations have many benefits when used to promote student learning. However, careful consideration of a suitable pedagogy is paramount to its success. A student-centered, learner-directed, approach is required which emphasizes experiential and active learning. The key to success is task design with quantifiable measurable metrics for task complexity and solution. Only then will 3D virtual worlds become accepted as a valid space to engage learners in meaningful education.

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03.

Immersion Idaho: An Undergraduate Research Program for Immersive Virtual Reality Development

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Abstract: Immersion Idaho is an educational project for teaching undergraduates how to use and develop immersive virtual reality technology to capture historical sites throughout the state of Idaho. Material is captured at a resolution of 100 Megapixel per eye in stereoscopic spherical panorama and tools are being developed to provide immersion at photo-realistic quality. Digital reconstruction and recreation of historical sites produces results that are sufficiently realistic to appear as if you are viewing them through a large window. Web delivery to HMD systems is a core component of the activity.

One Sentence Summary: Immersion Idaho is an educational project that teaches undergraduates how to develop photo-realistic immersive technology by digitally capturing and virtually reconstructing historical sites in the state of Idaho.

Introduction : Immersion Idaho is an educational project for teaching undergraduates how to use, design, and develop Virtual Reality Environments and Tools in support of Digital Heritage within the state of Idaho. The students within the program get hands on experience capturing 3D content, building virtual reality environments, and developing software in support of VR. Immersive Hardware, including Oculus Rift, Gear VR, Google Cardboard, and traditional CAVE immersion systems are utilized. Real-world 100 megapixel scans of Idaho historical sites are captured and edited to build immersive tours navigable within virtual reality headsets and large format displays with photo-real visual quality. The ongoing project involves joint work between Boise State University and the Idaho Historical Society. Resulting collections are disseminated to all parties involved and are made publicly available via the web. Existing capture sites include Historical Boise Train Depot, Yellowstone National Park, and the Old Idaho Penitentiary. Ongoing summer 2015 captures include the Idaho Capitol Building, Historical Franklin, Pierce Courthouse, and additional Idaho historical sites.

Project Outcomes

This project produces outcomes in photo-realistic immersion, education, research, and digital heritage. Students gain expertise in immersive capture of historical sites as well as an introduction to core digital heritage issues. New techniques and tools for digital capture, digital production, and immersive interaction will be built and tested at sites managed by Idaho Historical Society. In addition, all collected works are made available at multiple resolutions via a WebVR site for head mounted displays.

Immersion Technology System

Immersion Idaho uses virtual reality technology for photo-realistic capture, digital content creation, immersive display, and distribution of VR scenes. A custom capture rig enables immersive capture of 360x180 degree 100 megapixel per eye stereoscopic panoramas. This visual fidelity provides an extremely realistic immersive experience. Collected digital captures are converted to virtual environments, utilizing COTS and custom software. Digital content tools allow for annotation and integration and mixing of CGI. Digital editing and lighting of stereoscopic content is supported through the use of customized Photoshop tools, Maya templates, and custom software. Display and immersion is supported via a custom VR platform available on Large Format Displays, Occulus Rift, and GearVR display systems. Distribution of VR scenes is made available via WebVR web sites and customized Javascript applications.

Boise State University Immersion Laboratory

Production and Project Challenges

Significant challenges were discovered during the course of project production. The most challenging aspect of all project work was the presence of people at capture sites. Given that many sites are tourist locations people are always present and regularly walk in front, around and look directly into capture equipment. This required the development of a production process for over-collecting data and manually creating clean data sets with people removed from the capture. This issue is present even with high-speed capture equipment and is a permanent issue. Additionally, students learned through initial mistakes the importance of checklists and thorough equipment checks prior to leaving for field capture work. A participant's personal attention to detail in all areas increased significantly after a single instance of forgetting a key piece of equipment for an in-field capture. In-field tools for checking the quality of captures is lacking and bright light makes reviewing LCD display systems notoriously difficult on capture devices. These two problems can lead to significantly wasted field work. It is necessary to have shades for blocking the sun when looking at backlit devices. The importance of team-work for people management, safety review, and site scouting was quickly learned by teams of students independent of instruction.

Student teams were particularly adept at self-regulating on-site task distribution. Notably an individual participants basic skill level was not a barrier to their participation in the project as the student teams were highly effective at allocating tasks that matched a variety of skill levels dynamically. The VR production process contains a large number of small and medium size tasks that can be scaled based on a participants skill level.

Collaborating Organizations

This educational research project involves participants from Boise State University and the Idaho Historical Society. Research and development work is being performed by students and faculty within the Computer Science Department of Boise State University. The Idaho Historical Society is providing and support access to a variety of Idaho historical sites, including sites with limited public access.

Digital Heritage Activities

Core work in digital heritage involves detailed record keeping during the capture process, implementation of tools for digital repair and construction, integration of multiple meda types including video and photographs into immersive environments, manual and automatic annotation and tagging as well as support for broad dissemination via download and WebVR.

Content Creation Techniques

New immersion techniques will need to be researched and developed as part of this ongoing work. Specifically experiments in digital lighting from captures for CGI rendering, dynamic automatic stereoscopic alignment, immersive navigation in large panoramic volumes, scene compression, automated digital tagging and masking will all be engaged in over the course of the project. Initial experiments will begin with known techniques and students will gain experience with these techniques as they work on this project.

Undergraduate Activity

The students involved in the program get real world experience with virtual reality from capturing physical environments, developing VR software, and testing and deploying VR environments on multiple platforms. In addition they get the opportunity to develop and experiment with digital content creation as an artistic activity within the program. Students who participate in the program get exposure and training on all current virtual reality technology and learn how to create compelling virtual reality environments, tools, and displays for digital immersion within Idaho historical sites. Students engage in immersive content capture in the field, digital content production, and software development as part of this project on a regular and ongoing basis.

Unique Educational Aspects of the Program

An educational program in Immersive Virtual Reality presents unique benefits to student participants not typically found in traditional computer science internship and research programs.

Students gain experience in field work, software development, digital content creation, and human factors testing. In addition the range of tools and activities within a program collecting and generating immersive environments provides a broad range of tasks for every student involved. VR Capture and construction is large enough to contain tasks for students at every skill level while being small enough to allow every student to make a significant contribution on the project as a whole. The ability to directly see how there work directly impacts the results of the program significantly helps to maintain student engagement and student engagement is critical for significant learning to take place. In addition virtual reality development contains enough medium size problems that freshmen are able to contribute immediately and can be provided with a set of ever increasingly complex problems as their skills develop throughout their undergraduate years.

Conclusion

This project provides undergraduates within the state of Idaho a significant opportunity to develop multiple skills simultaneously. Students involved with the project do field work within the state of Idaho, learn key computer science skills, and gain an understanding of key important elements of virtual reality and digital reconstruction. In addition the project begins the process of building a historical digital immersive record of key Idaho sites, including Yellowstone National Park, a UNESCO World Heritage Site.

Acknowledgment

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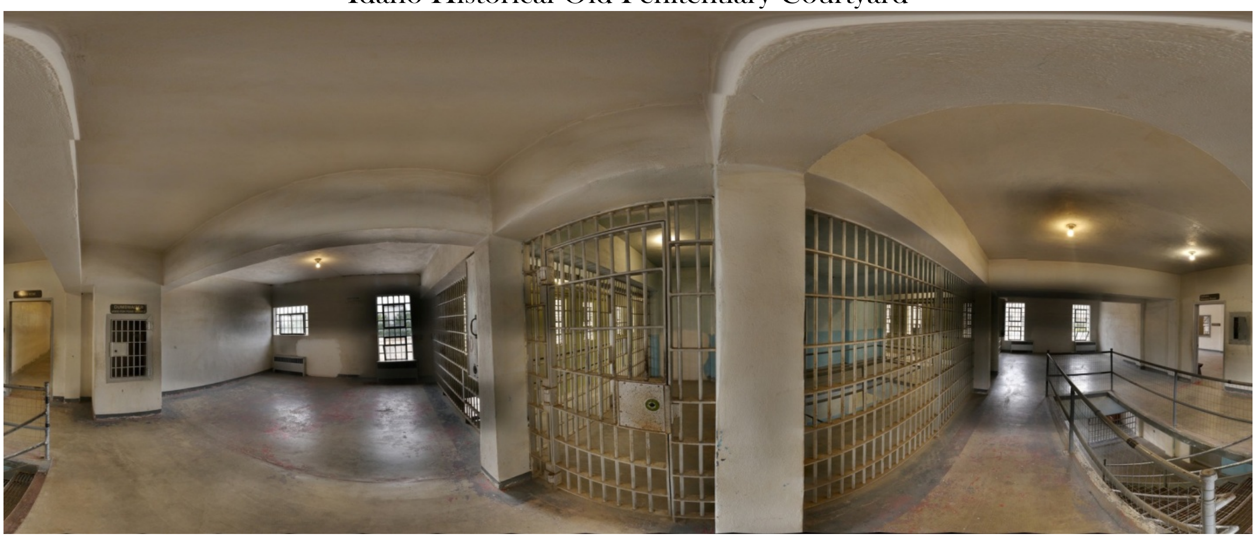
Idaho Historical Old Penitentiary Courtyard



Idaho Historical Old Penitentiary Gallows Entrance

Yellowstone National Park: Yellowstone Mammoth Hot Springs Location

Yellowstone National Park: Lake Yellowstone

Boise Historical Train Depot Main Entrance

04.

Using Web3D Based Technology as a Lifelong Learning Companion Tool: a Use Case

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Abstract: Advances in research and development related to computing in the web age, information and visualization technology, including an increase on accessibility to advanced digital resources have allowed to setting up an exploratory knowledge based learning process aiming to stimulate children's researching and acquiring scientific knowledge since k-12 levels. Individuals' engagement in this learning process has impacted on ones' lifelong learning, digital literacy and creative computing skills enhancements through using Web3D based information and visualization resources as learning companions and for supporting scholars' understanding primary school's scientific concepts. A combination of child-driven learning, computational thinking, creative computing, constructionism and immersive education concepts has supported this exploratory learning process sustainability. In this paper, the impacts cited above are presented and discussed. The discussion is done through describing a use case, which is a real life example of how to using Web3D based technologies as open educational resources have been applied for sustaining human computer interactions. Including that Web3D technologies have served as lifelong learning companions and stimulated young children to become creative content producers through using an interdisciplinary combination among school curriculum's scientific concepts, computer science and computer graphics principles.

One Sentence Summary: This work has inspired individuals' hands-on advanced Web3D technology to produce digital content since K-12 education, resulting in stimulating ones' lifelong learning and professional enhancements with sustainability.

Introduction:

Advances in research and development related to computing in the web age [1], information and visualization technology [2], including an increase on accessibility to advanced digital resources [3] have allowed to setting up an exploratory interactive knowledge based learning process aiming to stimulate children's researching and acquiring scientific knowledge and digital literacy skills since k-12 levels [4], [16].

Individuals' engagement in this learning process has impacted on ones' lifelong learning, digital literacy and creative computing skills enhancements through using Web3D based information and visualization resources as learning companions and for supporting scholars' understanding primary school's scientific concepts [4-6], [16].

A combination of child-driven learning [7, 8], computational thinking [10, 11], creative culture and computing [9, 12, 13], immersive education [14] and constructionism concepts [15], including advanced Web3D-based technology has supported this exploratory, interactive knowledge-based learning framework process sustainability over the years [4, 16].

In this paper, the impacts cited above are presented and discussed. The discussion is done through describing a use case (UC). The UC is a real life example of how to using Web3D based technologies as open educational resources have been applied for sustaining human computer interactions since k-12 levels. This UC is a proof that Web3D technologies have served as lifelong learning companions and stimulated young children to become creative content producers through using an interdisciplinary combination among school curriculum's scientific concepts, computer science and computer graphics principles as well as digital culture features.

With support of human computer interaction (HCI) studies [17] and action research principles [18], this work's data have been collected via author1's action research and participatory observation related to students' creative digital artwork at a k-12 primary school environment. It includes informal e-mails and talks with former students and their publications in blogs, author1's computer files, video and audio recordings of this long term interactive knowledge based learning framework process implementation [4]. And adding to these, former students' analysis about this learning framework process impacts on their lives' trajectories.

However, through stimulating individuals' hands-on web3D based scripting languages such as X3D for producing content can highlight the idea of bringing the understanding to the K-12 level students about what is in behind a 3D interface and its interrelation with k-12 curricular topics as English language, geometry, arts and math.

This Work Dialogic Theoretical Support And Educational Strategy Integration

This work theoretical support has extended our previous work [16] through a combination of child-driven learning [7, 8], computational thinking [10, 11, 25], creative culture and computing [9, 12, 13], immersive education [14] and constructionism concepts [15]. It has used a dialogic process, in which "various approaches coexist and are comparatively existential and relativistic in their interaction [23]." And this incremental dialogic theoretical interaction has supported this work interactive knowledge-based learning framework strategy for diffusing digital and scientific knowledge as well as stimulating individuals' engagement in open-ended educational processes [4].

Child-driven Learning (CDLE)

In a similar way to the investigation in [19], this work has explored the concept of child-driven learning (CDLE) and its two key features which are "the changed relationship between teacher and student, and the provision of a resource-rich, activity-based curriculum for learning". It has occurred through applying the principle of 'playing'. "Play involves the consideration of novel combinations of ideas, and the hypothetical outcomes of imagined situations and events. It is a form of mental exploration in which children create, reflect on, and work out their understanding".

Hence, an increase to accessing computer technology, in particular, advanced Web3D-based technology has allowed to exploring the concept of CDLE for extending the idea of playing to real time symbolic representation and reflection with children about computer based exploratory learning opportunities with support of applying scientific concepts referent to k-12 curriculum.

Currently, a mix of ordinary computer tools such as a notepad, a web browser as FireFox™ and a computer with a graphics processing unit (GPU) able to run WebGL libraries [20] can and has provided formal and informal transformative human computer interactions (HCI) between an educator and a student, of high quality, at low cost.

An informal real life example of that happened between author and a 6th grade student (6thGs) in June 2015. Author1 was researching on the web about an international learning opportunity, which came from his participation on the European Immersive Education Summit (IED) 2014 [14], inside the pedagogic coordination's room. The opportunity is related to students from Ernani Silva Bruno (ESB) Primary School participating in IED Minecraft™ learning network that has involved K-12 iED clubs [14].

During the conversation the 6thGs said that he knew some of Minecraft features, such as a user can build a Minecraft's interface through integrating Lego-based blocks. And that some of his colleagues from 6th grade classes have played Minecraft™. This is a factor that can contribute for implementing and sustaining the project at ESB Primary School.

Then, author1 told him that the Minecraft project has been built at ESB Primary School. Students from 8th grade have been invited to take part of it through an afterschool educational program involving a blend of computer programming, arts and culture for stimulating individuals' learning. However, it has been addressed bureaucracy aspects of ESB Primary School do not having the institutional power of installing new software at school level beyond one computer. So, installing software is a type of action requires a certain amount of time which involves the security system management approval and consequent installation of the necessary software in the other twenty Core i5 computers of ESB's computer lab.

In a sequence, author1 explained to the 6thGs that it has also been possible to create virtual worlds (VW) across using scripting languages referent to Web3D-based technology and low cost digital tools as explained in the beginning of this section and in previous work [16], including that these technologies' potential is inside ordinary peoples' homes. These technologies integration has allowed individuals also building virtual worlds' interfaces within the logic of creating Lego blocks via using computer programming languages and techniques to build simple and complex geometric shapes and transforming their properties, for instance, as in virtual reality (VR) systems software like in [21, 22].

VR systems, such as 'The virtual reality programmer's kit' [22] have applied an integration of computer language and computer programming techniques to develop polygon-rendering systems. For instance, Rend386 is "a system software that takes the polygons used to design objects and draws them on the screen, taking into account things like perspective, and your position relative to the objects. The collection of objects drawn on the screen becomes a virtual world [22]."

The possibility of building simple and complex VW interfaces using a digital tool such as Minecraft™ blocks and/or a computer programming script have lead individuals (author1 and 6thGs) to experience a computational thinking feature which is abstraction and decomposition when attacking/understanding a large complex task or designing a large complex system. "It is separation of concerns. It is choosing an appropriate representation for a problem or modeling the relevant aspects of a problem to make it tractable. It is using invariants to describe a system's behavior succinctly and declaratively. It is having the confidence we can safely use, modify, and influence a large complex system without understanding its every detail [22]."

Then, the student was asked if he would like to experiment with the mentioned web-based technologies within a small scale workshop. He said "yes".

After that, with CDLE mentioned features support, during forty minutes, author1 and the 6thGs interacted via diverse learning activities. It was created a folder in the computer for storing the files. Subsequently, the X3dom [21] site was opened on the internet, allowing and supporting HCI and individuals' reflections about cognitive abilities enhancements related to visualizing and creating digital content as well as stimulating ones' reading and writing skills. For instance, in English language within a viewpoint of this language relevance for an individual's lifelong learning, communicating, and working in the digital age. The next step was exploring the X3Dom framework tutorial via reading, writing and reusing a programming code referent to a mix of Hypertext Markup Language (HTML) and Extensible 3D language (X3D) in figure-1.

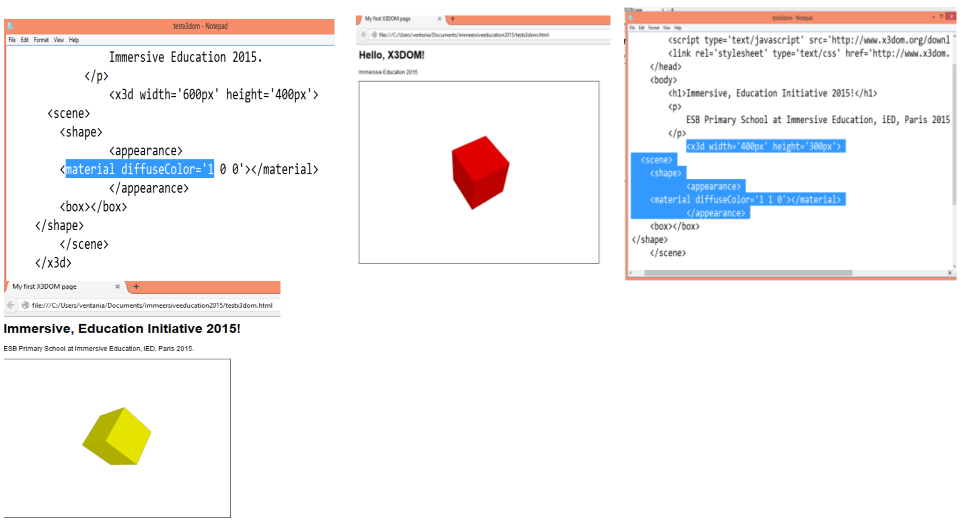

Figure 1. A symbolic representation of the interactive process of applying a real time VR system related to Web3D-based technology (involving computer languages and techniques) to support HCI between autor1 and a 6thGs for creating 3D content and reflecting about interdisciplinary learning possibilities as well as digital and scientific knowledge diffusion

At the end of this small scale information visualization and interactive workshop, the 6thGs took notes related to what tools and how to use them at home for attempting to do the experiment himself. In addition, he said that would ask his aunt to help him to setting up the tools in her computer for experiencing the interactive creation of digital objects. Then, the 6thGs was invited to participate in the afterschool project and he accepted to take part of it. After four days author1 and the 6thGs meet informally at ESB's school yard. The student said that although he accessed the X3Dom web site he had memory and technical problems in terms of remembering how to do the proceedings to achieve the performance of creating a digital object and visualizing it as in figure-1. However,, both combined to do another workshop during the next afterschool project learning time.

Computational Thinking

This work has taken into account that the computational thinking concept's characteristics have addressed, among others, "**a way that humans, not computers, think**. Computational thinking is a way humans solve problems; it is not trying to get humans to think like computers. computers are dull and boring; humans are clever and imaginative. (...) Equipped with computing devices, we use our cleverness to tackle problems we would not dare take on before the age of computing and build systems with functionality limited only by our imaginations; **Complements and combines mathematical and engineering thinking. (...)** Computer science inherently draws on engineering thinking, given that we build systems that interact with the real world. The constraints of the underlying computing device force computer scientists to think computationally, not just mathematically. Being free to build virtual worlds enables us to engineer systems beyond the physical world; (...) [9]."

The HCI between author1 and 6^{th}Gs in CDLE section is a real life example of how the computational think characteristics, such as the ones described in this section, can be achieved in k-12 educational settings. For instance, through including accessible advanced digital technology for supporting k-12 curriculum content development within a transdisciplinar way [28] and inspiring individuals' digital and scientific knowledge enhancements across using 'learning by doing' approach, which is a constructionism characteristic.

Constructionism

Constructionism is a constructivist learning and instruction theory. It supports that building knowledge occurs best through building things that are tangible and sharable. According to Ackerman's investigation, constructionism "states that children are the builders of their own cognitive tools and their external realities. In other words, knowledge and the world are both constructed and interpreted through action, and mediated through symbol use. Each gains existence and form through the other [15]." Therefore, constructionism has supported a combination of learning by doing approach with a growing use of digital technologies within a k-12 education development for stimulating and sustaining individuals' education [19].

Learning by doing is an approach that we use when learning, for instance, a skill. In other words, is "the perceptive-motory method, which involves watching, touching, testing, and then imitating or retesting." It is the method by which a child initially experiences and learns until artificially develops the symbolic-reconstructive method. The symbolic-reconstructive method encompasses "decoding symbols (language) and then mentally "rebuilding" the transmitted concept." It is associated with learning processes, for example, reading, understanding, reflecting, reasoning, induction, deduction and involves processing information being aware and conscious. However, the perceptive-motory method or the primary learning mechanism "can only be activated, if the object belongs to the physical world". Due to "the "undo" option, the same trial and error approach entered the world of software", enables ones to use the learning by doing method [24]."

In this context, VR represents the tool that provides connecting the perceptive-motory system to nonphysical objects - virtual digital objects [24]. VR technology has allowed individuals using the learning by doing approach, as in author1 and 6^{th}Gs workshop, and materializing a mathematical space in which they touch a molecule and modify its structure such as exploring a mechanism or human body from inside. Considering the process of "transmitting knowledge: if the knowledge consists of a group of concepts with structure (links and relationships), its transmission via conventional media implies a sequential single-channel protocol that involves the disassembly of the structure into nodes, relationships and constrains." In contrast, knowledge transmission via hypermedia and or VR interactive techniques can bring about "interactive transmission of structured knowledge spread across many channels along with the full set of links and relationships" [24].

Immersive Education

Within our contemporary digital culture, an "interactive transmission of structured knowledge spread across many channels along with the full set of links and relationships [24] can be done throughout the concept of immersive education (IED). IED and its features have formed a flexible learning platform that combines interactive 3D graphics, simulation technology, VR, web cameras and rich digital media with collaborative online course environments and classrooms. IE has given participants a sense of "being there" even when they cannot attend a class. IED has provided individuals with the ability to connect and communicate in a way that greatly enhances a learning experience [14].

In this context, IED as contemporary education concept can and has supported informal and formal learning experiences outside and inside a school environment using characteristics from creative culture and computing [12, 13].

Creative Computing

Paraphrasing the work in [13], creative computing (CC) has supported the development of personal connections to computing, by drawing upon creativity, imagination, and interests. CC is about empowerment. It means stimulating young people using computers to become designers or creators. Creative computing emphasizes the knowledge, practices, and fundamental literacies that individuals need to create the types of dynamic and interactive computational media that they enjoy in their daily lives. Engaging in the creation of computational artifacts prepares young people for more than careers as computer scientists or programmers. It supports young people's development as computational thinkers – individuals who can draw on computational concepts, practices, and perspectives in all aspects of their lives, across disciplines and contexts.

This section dialogic theoretical interrelation and real life practical examples have addressed several learning principles which can and have served as a base for establishing the cultures of creative concept having in mind the "importance of recognizing playfulness and creativity to develop societies prepared to accommodate the rapid changes associated with technology and globalization [12]."

Applying Web3D Technology as a Lifelong Learning Companion Tool

The rapid world society changes associated with technology and globalization have allowed this evolutionary educational work sustainability over the last decade. This work evolution has encompassed collaborative learning experiments developed with support of Web3D based technology inside ESB Primary School computers lab and impacts on former students' lifelong learning and professional attitudes as in [4-6].

In essence, the starting point of HCI among author1 and students has been similar to the author1 and the 6^{th}Gs described in the 'This Work Dialogic Theoretical Support And Educational Strategy Integration' section.

Evolutionary research and development R&D related to accessible Web-based markup languages and computing techniques as well as open source software have brought about an increase in this experimental work. For instance, the increase has been identified through a former student (MG)'s lifelong learning attitudes since k-12 levels. It includes his reflections about how 3D and digital technologies have supported his knowledge development.

This section development has been inspired in a MG's thoughts and attitudes which have served as a real life proof of effectiveness of an educational work that began inside ESB Primary School and has stimulated individuals' open-ended education. His speech received via author1's email has small changes, however attempting to keep its essence.

The educational context

"When I was a Kid I'd been introduced to 3D and digital world through my brother who had already done some works with my teacher of computer. Once my brother showed me his first project on the school's radio studio where he'd became a leader. We didn't have a computer yet. Visualizing with my brother's job my breath went away and my mind suddenly had started thinking how much things I would do with that tool… My brother explained me a bit how that worked and my wish for learning that developed more and more, then he told me who'd taught that to him was our teacher (author1). Those were enough to looking for him and develop my knowledge about that magical tool."

In this educational situation, it has been identified CDLE [7, 8] and cultures of creative concepts [12] characteristics, such as young children' knowledge sharing and collaborative work development.

"Author1 (my teacher) loved the idea to teach me what he knew. He'd taught me how to use the tool named Virtual Reality Modelling Language (VRML) [26] (are scripts made for reproduce 3D through themselves) and then I've felt in love for digital technologies and since then I've left my mind fly away on digital design."

An example of MG's artwork he did just after he left ESB primary school is bellow in figure-2. It addresses features related to open-ended education with support of his computational thinking and lifelong digital literacy skills enhancements.

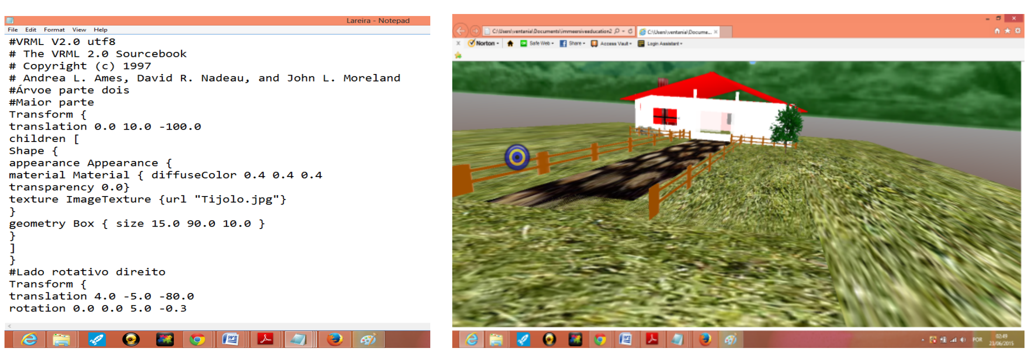

Figure 2. MG used a combination of computer science features such as computer programming, computer graphics and digital art techniques through applying accessible Web3D-based tools

MG's artwork development has brought about a real world example of creative computing implementation which has supported "young people's development as computational thinkers – individuals who can draw on computational concepts, practices, and perspectives in all aspects of their lives, across disciplines and contexts [13]."

MG's skills and competences have improved since his early ESB school days. His knowledge evolution has had meritocratic evidences based on his lifelong learning efforts. However, as he declared 3D and digital technologies have stimulated him learning and professional attitudes. MG is graduated in Graphics Design and has worked as graphic designer. His artistic work has been to do 2D drawing composition and exposing it on the internet [28]. He has also developed skills related to 3D modeling using Blender™.

His evolutionary digital and scientific knowledge enhancements have been an effective evidence of how to applying the concept of creative computing can empower an individual.

We finish this use case with MG's critical thoughts:

"Although the time has changed, the children like me, need to identify something new, something that makes them take out junk activities to enjoying a new way on their lives. Maybe it would be hard to do, but not impossible. If we develop it with initially with whom (ones who) like arts maybe it be easier. An idea for starting is using the tool in some presentations where the kids being present showing them all possibilities and telling them that they are capable to do it too. Since then is necessary make a study group (like a course) teaching the kids all the tools, then we can supplement others grades on the school working together with the others teachers. Organize a technology fair would be another alternative, but actually in the future when the firsts students have works for show. It can be interesting for the others students... VRML it's no doubt a great tool to develop kids, teens, youngers, adult's creativity, fast-thinking, capacity to solve problems, logic and etc."

Final Considerations

It has been used Web3D based technology as a lifelong learning companion tool inside and outside a municipal primary school in a developing country. This Web3D utilization has supported an exploratory and interactive knowledge based learning framework enhancements as well as addressed scientific and digital knowledge diffusion to ordinary individuals.

Hence, qualitative data have showed that this kind of knowledge diffusion inside and outside a primary school has brought about stimulating individuals' lifelong learning attitudes and impacted on their education and professional lives [4], as it is the real life MG's case described in the 'Applying Web3D technology as a lifelong learning companion tool' section.

The HCI between author1 and 6thGs and case study examples in this paper have addressed how a teacher can "engage children by helping to organize and assist them as they take the initiative in their own self-directed explorations, instead of directing their learning autocratically. Flexibility is the most important feature of the new role the teacher will have to play in such an environment [19]." In a CDLE, sometimes teachers will find that their role tends towards the old model of teacher as giver of knowledge because at that particular time, students require guidance and training in a particular task or content area.

"Technology takes a special place in the CDLE as a powerful tool for children's learning by doing. Children's traditional classroom tools - pencils, notebooks, and texts - are still vital. But for children to assemble and modify their ideas, access and study information, they are inadequate. Computers, video, and other technologies engage children with the immediacy they are used to in their everyday lives, and bends it to a new pedagogical purpose. Really, it is not what equipment is used in the classroom, but how that equipment is used that will make the difference. We think that technology must be thought of as an integral component of the curriculum, a chameleon-like tool that can be used with almost any content. Computers can be used as writing tools, spreadsheets, and mathematical problem-solvers [19]."

The conceptual knowledge that has supported this work development in combination with the empirical practices of using web3D-based technology as a lifelong learning companion tool has showed a potential of using computers as advanced information visualization creative writing instruments and impacting on individuals' digital literacy and transdisciplinar scientific knowledge enhancements.

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06.

Appropriating the cyberspace: an immersive experience for college applicants

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Abstract: The development of new devices capable of playing virtual reality and high quality stereoscopic video have made possible the creation of new audiovisual proposals to deliver information and give the user more interaction with the content. This paper presents an application for smartphones that allows the user an immersive 3D and 360º tour of an existing building, in order the people that eventually use its facilities will visit and learn about it. The conceptual frame used is the concept of cyberspace as a place where users get a better immersion if they do some activity inside. Also, we consider the increasing availability of devices capable of playing 3D videos, as the framework for the audiovisual and software production model adopted. The application was assessed using a quasi-experimental design, through user survey. The results hinted at the elements that must be improved in the future design of immersive audiovisual experience, and also highlighted the attributes that has the use of a smartphone as a new technology with high availability.

One Sentence Summary: The use of immersive and interactive 3D and 360º audiovisual tour sets several challenges both in functionalities and narrative aspects.

Main Text:

1. Introduction

The term cyberspace was used for a while to refer to everything internet related: its content, functionalities and user activity. Using Echeverría (1999) as a reference, Javier Royo (2004) interpreted it as a new space provided by the new technologies, where people develop and communicate, in an environment where design takes a major role. This translates the space and tools that humans use in real world interactions to an intangible digital space, that can also be travelled and inhabited (Royo, 2004: 32-33).

Taking in mind the paradigms defined by the human-computer relationship, this last decade the technological capacity of graphical processors have made the generation of images in smaller devices than ever before, mainly in smartphones. While the WIMP (Windows, Icons, Menus and Pointers) design dominates cyberspace access, new hybrid interactions have surged based on hypertext, metaphors and *ubiquitous computing* (Dix, A., Finlay, J., Abowd, G.D. & Beale, R., 2004).

In this new space, audiovisual resources have been used to achieve a higher immersion in multiple dimensions, searching for new sensations and better realism, as Pueo y Sánchez (2013: 14) tell when referencing that screens must provide to an audience that has experienced

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audiovisual products from an entertainment industry. In this way, the representation from computer generated graphics -such as Virtual Reality that incorporates 3D, sound and tactile feedback (Desai, Desai, Ajmera, Mehta, 2014)-, is already available in the videogames industry, backed up by the growing potency of graphics cards, has been taking steps into becoming more like the real world. Even if it is not a new concept (Olson, Krum, Surna & Bolas, 2011), the appearance of the Oculus Rift has opened the gates of virtual reality development in multiple ways, from the visualization of architectonic projects, phobia treatment, first person video games and military and laboral training. This is because the Oculus Rift is not bound by the limitations of its predecessors, like the obsolete Virtual Boy from Nintendo (1995) or the CAVE (Cave Automatic Virtual Environment) environment (Desai, Desai, Ajmera, Mehta, 2014; Halley-Prinable, 2013).

Thus, the exploration of high quality images via stereoscopic vision is a new path that inches closer to the feeling of being in a different place.

The technologies which allow the interaction of audiences with the audiovisual content make the audience develop their own personal narrative, acting as subjects to the action and building a message using their own repertory (Freitas y Castro, 2010). In this way, the option of experiencing the space from a recording to freeform and real time, overcomes the obstacle produced by the generation of computer generated images. The physical action of the user moving his head to look around has an immediate feedback on the cyberspace presented to him, achieving higher immersion because the user is not only there, but his actions also have consequences on this cyberspace (Freitas y Castro, 2010). Although, this immersion is fragile because the trance that keeps the user in the virtual world can be broken at any moment. There is a divisory line that separates the real physical world and the presented cyberspace, where the physical object that serves as an interface between worlds becomes the fourth wall, as in theater (Murray, 1999: 119-138). This object is the mask, the vehicle that the user takes to make a journey through the cyberspace. There are users that feel more comfortable in this vehicle, maintaining the control and separation of both worlds; and there are others that would rather not take part of the experience, as shown by the findings of this article.

2. Material and methodology

This article's purpose is to showcase an innovative experience had with high school students that came to the career fair of the Universidad Católica, particularly those interested in the journalism, audiovisual production and publicity programs.

The main objective of the project was to identify the strengths and weaknesses of immersive lenses, whose device allows for the visualization of videos based on immersive narration for the exploration of the school's facilities, and to showcase prerecorded common scenarios they might experience in their formation.

The narrative experience was a tour of the Communications Faculty's facilities. Through different navigation paths, the use could explore visually (via video) and auditory (via sounds) the different areas and workspace situations in the faculty's media; and have an impression of the school of communications.

All the classrooms and facilities of the faculty are in a single building. Each floor has different work units and classrooms.

2.1. Immersive device

In the planning of this research, the available immersive technologies were evaluated. In an alliance with the chilean company *Inmersus*, the head mounted devices were selected along with the recordings of the faculty's facilities.

These last years, the industry and the market have opted for the use of mobile devices for on site experiences. The advances of processors, memories, graphics cards and storage capacity has given and edge to the construction of devices that use smartphones in a frame. Multiple experiences (Petry & Huber, 2015; Olson, Krum, Suma, & Bolas, 2011; Hoberman, Krum, Suma, & Bolas, 2012; Thomas, Bashyal, Goldstein, & Suma, 2014; Steed & Julier, 2013) show progress in this option. for instance, Petry proposes an immersive system using smartphones along with navigational elements that allow the users to choose the temporal and spacing moments of the narrative.

Taking this knowledge, and the enterprise's experience, the investigation designed an exposition in the fair with five Samsung *Galaxy S5* smarthpones. All of these using Google's Android operating system. To build the immersive devices, or HMDs (Head Mounted Displays), three cardboard frames from Google (*Google Cardboard*) were available, along with two VRHs (Virtual Reality Headsets) for smartphones from HOMIDO.

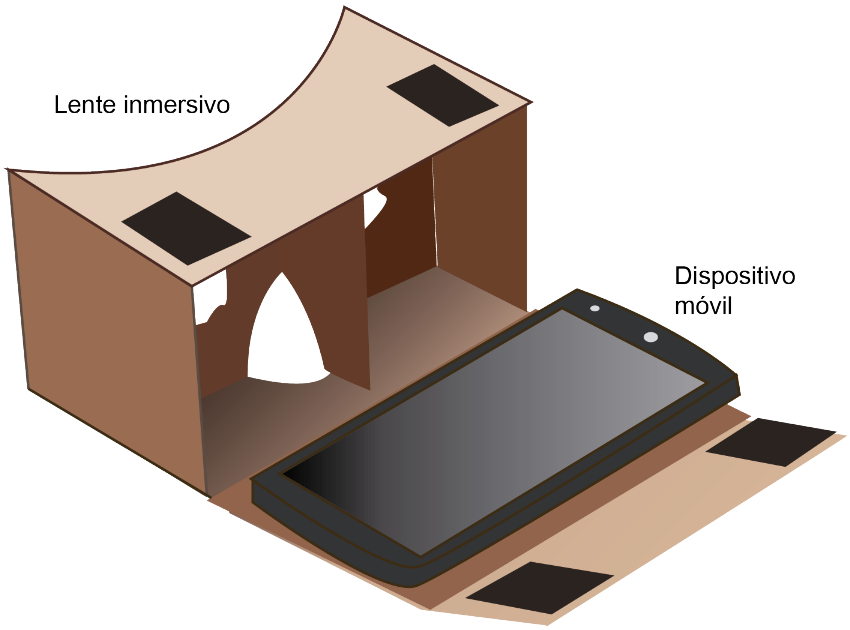

Figure 1. Immersive lenses system, developed by Google.

2.2. Recording process

Step 1: Script

The first task was to make a script for the immersive experience. The research team selected the most relevant instances to show to the potential students. Spaces with attractive audiovisual information were prioritized in order to motivate people without knowledge of the facilities or workflows that take place in them. There were seven common spaces to be filmed. Two of them were classrooms, two of them were recordings of television programs (one was the news set, another a study with spectators), a radio program with a guest, and two common spaces where only the environment would be shown. The shooting plan would take place in a single work day.

Step 2: The recording device

The recording device was built by the company Inmersus. It consists of a cube shaped frame that holds six *GoPro HD* cameras, mounted on a tripod at the base of the cube, with an incorporated microphone. (Figure 2). This recording system has an horizontal range of 360 degrees, and also allowed for the recording of panoramic angles, the ceiling and the floor beneath the spectator. The placement of the cameras wasn't trivial, as they had to be placed in a place where action could take place around them, with a distance radius of 75 centimeters. This is because the assembly process for the six images needs superposition anchors, that are transparent for the spectator unless objects come inside the defined radius..

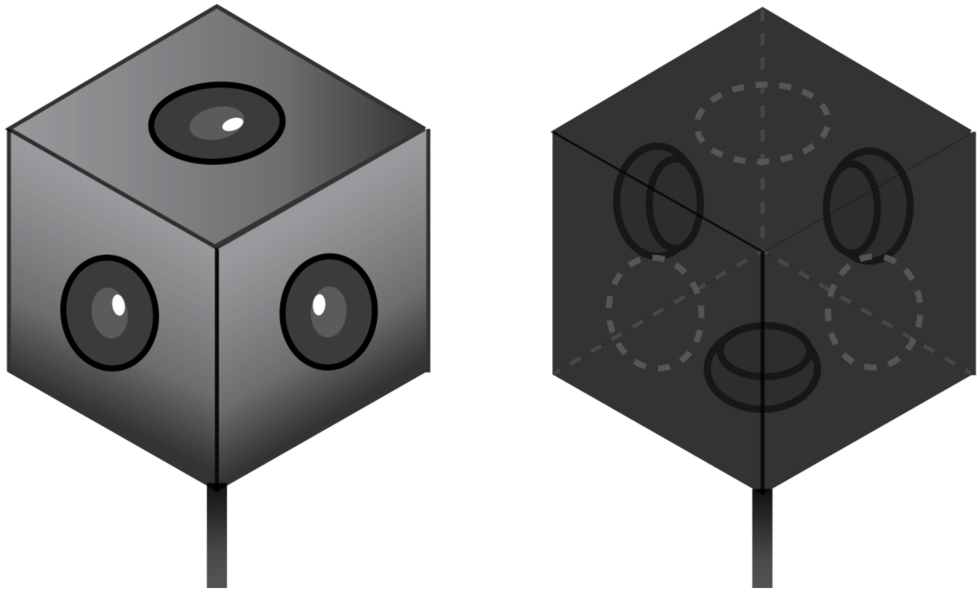

Figure 2. Omnidirectional cameras. Conformed by a cube with six cameras, mounted on one of its vertices.

Step 3: Staging and recording

The script described the places and actions that would take place, the priority was to showcase the everyday work that takes place in the Communications Faculty. The challenge was to make an audiovisual registry that allowed for the travel of an immersed virtual spectator, with an interesting story and interesting for a student in a fair full of different stimulus.

In practice, the script was written just registering the activities that take place in the facilities. Routine activities were recorded, with the usual persons that realize them in order to facilitate a natural registry and because, if the student chooses our program, he might be familiar with the places and persons he might encounter in the future.

An exceptional immersive scene was the welcome message of a teacher for future students (Figure 3). The 360 degrees cameras was placed behind the camera that records the foreground in the study, in order to see all of the work that takes place in the recording, the spectators and behind them, where stage lights don't illuminate, but the bulk of the work of recording a television program takes place.

Figure 3. Welcome message of a member of the Faculty for future and new students.

In this recording, and in each recording session, the camera was mounted in a fixed position -generally in the middle of the room- and via wireless controls the director started recording each take. Each scene had between four and six takes, around one minute each.

Step 4: Revision of the raw footage

The first revision was to choose the best take of each scene. For this, the responsible people of *Inmersus* presented a plain audiovisual montage that showed the six images side by side. The 6 images were synchronized between them and the audio. In this way, the first revision was a more technical one, selecting a single take for each one of the eight scenes.

Next an editorial revision took place, because the research team saw that three of the products were unattractive. One was a classroom where the audio was uninteresting because it took too long for the spectator to hook in. Also, the filmed subjects were static through the take, which wasn't visually attractive. Something similar occurred in the filming of the courtyard, because the spontaneous nature of the take rendered the minimum distance (75 centimeters) requirement useless. Also, the audio was cryptic for an external spectator. The last registry that didn't meet the criteria was the entrance to the third floor, where no movement was registered in the planes. The takes were right from a technical standpoint, but they weren't attractive for the viewer.

The other five takes were considered viable, and passed on to the immersive assembly stage, where the 6 videos are synchronized via software in order to make a video to be seen in a specific application.

Step 5: ON Video reception

Once the recorded scenes were revised, the following five videos were made:

- Being immersed in the recording of a television program in a station's studio.
- Being immersed in the recording of a TV news show, specifically in the interval between the host finishing a piece of news and the moment where we get back to the study to present the next piece.
- Being immersed in a classroom in a computer lab. Specifically, during a class explaining the usage of Microsoft's Project software.
- Being immersed in the emission of a radio interview. In the study a journalist starts the show and presents the interviewee, holding his vision on the controls (on the other side of the glass) in order to produce a good radio program (Figure 4).
- Being immersed standing in the middle of the courtyard of the Communications Faculty.

Figure 4. The radio study scene.

Step 6: Development of the immersive application.

Once the five videos were final, and knowing the immersive limitations of each, the main application was being planned. Specifically, how all these videos would be shown to the user through an application. The first thing that was decided was that there would be an entry point to the application. As this would be a journey through the Faculty's facilities, the viewer would first arrive at the faculty and then decide where to go. So the courtyard video was decided to be the entry and index of the application, so the spectator could travel through this yard, find one of visual landmarks, and select one of them to go to the place described in them (Figure 5).

Holding the stare into one of the landmarks would display a loading bar, so the viewer could understand that something was loading, and after a few seconds a new video would start. After this new video ended the application defaulted back to the courtyard video, in order to select a new place. In order to mark this video as a starting menu, the environment sound was deleted and replaced by a neutral music loop.

Figura *5*. Place index. Looking at a notice board the user went to the displayed place.

2.3. Career fair and enrollment

Once the application was finished, and the lenses dispatched, the research team made tests during the enrollment process and in the career fair of a chilean university, between december and january 2015.

The first time was in the three days of the career fair (Feria de Postulantes) of the Pontificia Universidad Católica de Chile, where hundreds of young people had the chance to familiarize themselves with the programs offered by the university,via brochures, information and student and teacher testimonies of each faculty. The advertising teams made guided tours, informative talks and answered the student's queries. In this occasion, in the Communications Faculty's stand the devices with immersive lenses were displayed so students could use them, with help of enrolled students that knew how to use them (Figure 6).

Figure 6. A student interested in the journalism program using the immersive device.

The second instance, after the postulation results were posted, had the new students present themselves in the faculty in the first days of january to enroll into their chosen program. This process had numerous tasks: tariff payments, data registry, documentation delivery, welcome instance from teachers and students alike, between others. In the welcoming, a stand was immersive lenses was available, where people who hadn't tried them in the career fair could use them.

2.4. Evaluation tool

Given that the usage of the device was in a real world environment, the design was nearly experimental; where the users were young people that came into the stand in both occasions, and wanted to try the device. Once the students finished using the lenses, the ones in charge of the stand made an open and closed survey questions. The questions were focused on demographic data, on the visited places, elements that seemed interesting, if they needed help to use the lenses, and comments on this process.

3. Analysis and results

After the two instances of the experiment, the measuring device was applied to a total of 49 teenagers, 25 in the career fair and 24 in the enrollment process. For most of them, that was the first time they did the university admission test, with an average age of 18 years.

Since the experience included lenses with a smartphone with the application already installed, the software was used in its 3D version.

The survey included a section where the viewers had to tell the places they went inside the application. The most visited place was the television study, followed by the radio study and, lastly, the news set.

24 people needed external help to use the application, while only eight reported that they intuitively knew how to use it.

In the participant's comments there was a general positive reaction to this experience: innovative, fun and interesting were the most used adjectives to describe it. Also, it was appreciated as a useful tool to showcase the Communications Faculty's facilities. In general the comments were biased towards the usefulness of this technology, and its innovation factor. There were not many mentions of the immersive feeling of the experience, but there were on its more superficial description, innovation factor, and its usefulness as a framework for new possibilities.

The negative remarks were towards the difficulty to leave the application, mentioned by them as the form to "escape" the places they visited, and the basic aspects of the experience. Just in two cases this negative comments were registered, while the rest appreciate the usefulness, dynamism and didactic aspects. In general, there was a good reception by the teenagers that took part, where the innovative factor was the most attractive element, recognizing the development opportunities of the experience.

Also, they were surprised by the fact that it was ran on a common smartphone. Not all of them recognized this, but those who did were surprised by the simplicity. In this sense, most users appreciate the technological qualities of the device, but they didn't were convinced about its utility.

4. Discussion and conclusions

From this experience, the users saw as advantages the incorporation of the movement of the head as a form to interact with the content. Unlike other mobile virtual reality experiences, most of them were rendered by computers or mobile devices with touch interaction with the devices. Via the usage of a mouse, tactile screens, keyboards, joysticks and other elements, the user makes decisions on the paths that he will explore. With this device, a new degree of freedom was opened, where the head movement is relevant to the interaction and navigation of the space (Petry & Huber, 2015). Furthermore, the real life content is different from computer generated graphics, where the environments are made via 3D rendering or digital animations. Through the recording of situations with omnidirectional cameras it was possible to make a new way to make interaction with narrative and audiovisual content.

As a second attribute, the user interaction advances to a new level, since the person can interact with the time and space of the situation presented by the device. Being immersive, he can involve himself visually and aurally, given the freedom to choose the angle or viewpoint of the situation. This opens a new array of possibilities to generate stories where the video producers must not only make a sequential script, but also take into account the different places where the user might have his attention.

As disadvantages, the research team and users saw that human movement -like walking, shifting, or running- is not necessary for the immersive system, alienating the visual experience with the life experience. Many participants moved themselves in place, forgetting that this movement wasn't registered by the device.

The reveal of the HMD affected the user choices, and the expectation of the experience.When choosing between the HMD and the cardboard frame, most users chose the second one. Many said they prefered that one because it was easier to install, smaller and less invasive of the head. While the HMD was twice as bulky, and was visually more complex for a new user. This showed that the presentation was as important as the content for future experiences. Taking into account what Murray(1999) said about immersion, the users showed a preference towards taking the virtual trip having always in their view the line that separates reality from cyberspace.

Finally, the development of new navigation elements is the next challenge, in order to address the problems like leaving a particular scene. In this experience, the user had to wait for the video to timeout in order to get back to the scene index, because there was no escape mechanism once you got into a scene. This also reasserts the observation that not all participants finished the experience, and that they returned the lenses while a video was still playing.

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07.

Statland, an OpenSim-based Way To Teach Statistical Sciences In Middle And High Schools

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Abstract: This work explores how teaching statistical science at middle and high schools can be established in a virtual world. In nowadays society citizens are called to play an active role, using data to solve problems in a wide variety of fields and applying statistical knowledge to social, economic, and ecological problems, in order to make decisions in situations of uncertainty. It is then important to begin the quantitative study of collective phenomena since the first years of compulsory education and, consequently, to provide teachers with adequate training. Statland was built as part of a project for the dissemination of statistical literacy at school, in collaboration with the Italian National Institute of Statistics. Statland is an island of the grid Techland, an OpenSim-based virtual world, where people log in as avatars. By exploring Statland and interacting with dynamic learning objects it is possible to learn the steps and methodologies required to perform statistical surveys. Statland is a virtual meeting place for students, teachers and statisticians who want to try out new approaches to the statistical sciences.

One Sentence Summary: Statland is a 3D virtual island where teachers, students and statisticians can join a 3D community of avatars to develop statistical science literacy.

Main Text:

Introduction

In nowadays society citizens are called to play an active role, using data to solve problems in a wide variety of fields and applying statistical knowledge to social, economic, and ecological problems, in order to make decisions in situations of uncertainty. So they should be able to interpret, translate and represent data to present their work.

For these reasons "mathematical competence and basic competences in science and technology" is one of the eight key competences of the "Recommendation of the European Parliament and of the Council of 18th December 2006 on key competences for lifelong learning" concerning school curricula [1]. Some mathematical competences involve skills related to the statistical thinking as the ability and willingness to use logical thinking and presentation modes (models, graphs, charts). On top of that "Uncertainty and data" is one of the four content categories for the "Programme for International Student Assessment (PISA), a worldwide study by the Organisation for Economic Co-operation and Development (OECD)" for 15-year-old students [2]. In the same way, "Measurements, Data and Prediction" are used by the Italian National Institute for the Evaluation of Education and Training System INVALSI [3]. So statistical sciences should be taught since the first years of compulsory education and should occupy a larger space than in the past. Consequently, it is important to provide teachers with adequate training to support the importance of statistical science in school curricula and prepare statistically literate citizens. They should receive “specific preparation in applied statistics and education in the pedagogical content knowledge in teaching statistics” [4, 5].

The Italian National Institute of Statistics (ISTAT)

In 2013 the Italian National Institute of Statistics (ISTAT) started a new national program of dissemination of statistical literacy at school [6]. Three series of learning packages were implemented for the different school levels (Primary, Middle and High Schools) to experience a different way of learning statistics concepts in the classroom. Learning packages, composed by spreadsheets, multimedia presentations and several tutorials, all in Italian language, cover both the mathematical bases of statistical surveys and the methodologies to implement them. These packages were developed by a network of researchers from ISTAT and the former Advanced School for Statistics and Socio-Economic Analyses (SAES). The ISTAT institution organizes specific training sessions and conferences to help schools in adopting and using the learning packages.

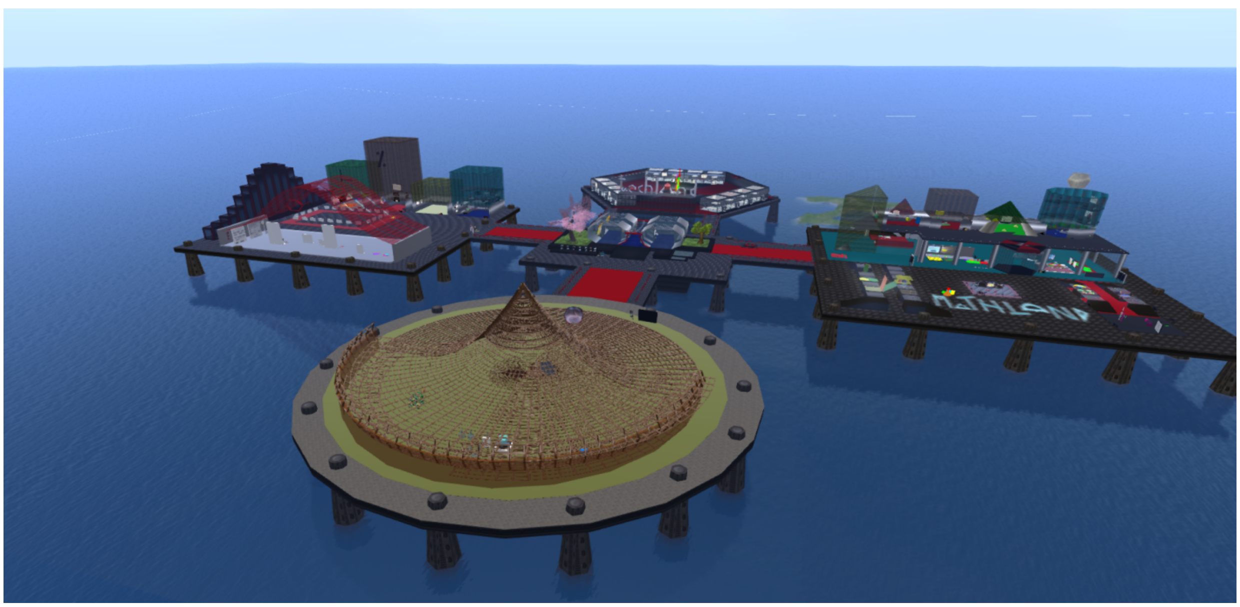

Figure 1. The main platform in Techland including Statland (left), TechStore, The Welcome Area and Chemland (center), and Mathand (right).

Techland

Techland [7] is a virtual world focused on math, chemistry, biology and earth science and it consists of both educational and service islands for teaching purposes (Figure 1.). It is based on OpenSimulator, the open source multi-platform, multi-user 3D application server to create virtual environments [8]. People can access this virtual world as avatars via a user interface called viewer, e.g. Singularity [9].

Since January 2015 Techland has been configured as a Hypergrid Grid, so it can be easily reached from other similar OpenSim-based virtual worlds using the same hypergrid facility [10].

The URL address to reach Techland is http://techlandgrid.it:8002. For further information about Techland projects go to http://www.virtualscience.it [11].

Statland

Thanks to her past experience in building virtual worlds, in 2013 the author joined the ISTAT project setting up in Techland a new virtual island focused on statistical sciences: Statland.

Pure mathematical concepts, like plane and solid geometry, due to the geometric nature of primitives (the basic blocks to build virtual words) can be easily "visualized" and taught by using virtual reality [12]. Mathland, a Techland island focused on geometry, is a concrete example of how virtual worlds can help to this purpose [13, 14]. On the contrary transforming numbers and Statland arithmetical concepts into 3D objects was not intuitive nor immediate and required a major effort.

Statland has been designed as a meeting place for students and teachers who want to try out new approaches to teaching and studying statistics science in a rigorous and yet amusing and motivational way.

Statland design has begun with the objectives of (1) promoting the development of statistical literacy in teachers and students, (2) promoting the cooperation between schools and official government institutions of statistics, and (3) integrating teaching and IT.

In Statland it is possible to walk around, following free or structured paths that explain steps and methodologies used to perform statistical surveys; it is also possible to interact with virtual objects and other avatars. Most of the learning packages from ISTAT are translated into 3D learning objects that can be animated by clicking on. Statistical concepts are then shown in a dynamic way through changes of location, shape, color and transparency.

Other learning packages are displayed in in multimedia presentations sliders, or by links to external web resources, in order to accomplish a synergy between various multimedia resources which are accessed directly “inworld”.

Statland is divided into four sections, one for each phase of the statistical survey: “Survey Design”, “Data collection”, “Statistical Data Processing and Analysis” and “Dissemination of Statistical Data” (Figure 2.).

The key concepts of statistical science and its essential glossary are shown in the "Survey Design" section. Here students learn how to plan a statistical survey. They become familiar with the relationship between the objective of the statistical survey and the selection of the observation unit, depending on the phenomenon to be analyzed (social, economic or scientific). Students can also experience the difference between a static survey, which provides a “snapshot” of the phenomenon, and a dynamic investigation, which highlights its evolution over time. Students also learn how to properly set up variables (categorical or numeric) and scale measurements; in fact some sampling frames and how to select the observation units are displayed in this area (census, random and non-random sample selection).

In the “Data collection” section the different ways of conducting a statistical survey are described: face-to-face interviews, telephone, self-completion questionnaires (paper assisted, or by computer) or administrative data. Guidelines to plan effective questionnaires are provided here, depending on the survey objectives and the output required.

Figure 2. Statland views: “Survey Design”, “Data collection”, “Statistical Data Processing and Analysis” and “Dissemination of Statistical Data”.

The benefits to collect data from administrative sources or directly from the observation units are shown here as well.

In the “Statistical Data Processing and Analysis” section, the heart of Statland, the mathematical concepts related to Frequency, Central Tendency and Dispersion are developed in a simplified way, suitable for middle schools pupils and the first years of high school students too. All contents are set up as 3D interactive objects and multimedia presentations.

In this section students familiarize with data sets, which are single spreadsheets where rows represent the observation units, and columns are the variables. So they learn how to capture, integrate, encode, aggregate and process data.

In the “Dissemination of Statistical Data” section there are series of interactive graphs, divided by type and use. With the aid of the ISTAT learning packages, students upload their materials and multimedia presentations, learning how to make self-explanatory graph or tables and how to format and present them appropriately, to increase their readability.

Other areas are set up for students: a “Quiz Area” with interactive questionnaires for the student self -assessment and an “Exhibition Area” where students show and present the results of their statistical surveys.

Teachers desiring to improve the effectiveness of their teaching using virtual worlds should first become familiar with the virtual environment, in particular master the movements of their avatar and communicate with other avatars/student both in text chat and by voice.

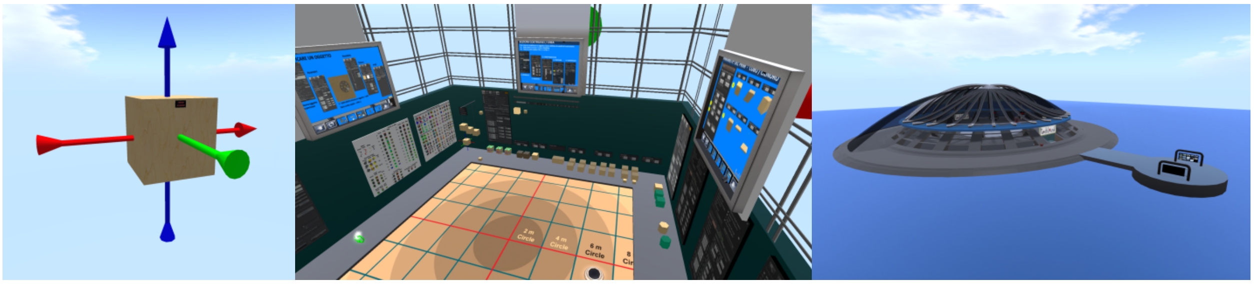

Figure 3. The “Prim School” (left and center) and the “Training Area” (right).

In Techland there are two training areas to provide support for these skills: The “Prim School”, where people can carry out self-paced learning activities about “inworld” building, and the “Training Area”, where all the functions of the OpenSim official viewer Singularity are explained (Figure 3.).

Learning set

For middle school students the best way to learn fundamentals of the statistical science is to carry out a statistical survey, concerning aspects of their daily lives. The pedagogical concept “learning by doing” is fundamental at their age.

In the last two years, the author has coordinated two similar projects in two different schools, combining both “inworld” and hands-on activities. These projects were divided in three steps: (1) the use of the ISTAT learning packages, (2) the design and implementation of a statistical survey and (3) the dissemination of results.

In step (1) of the projects, the contents of Statland were mainly shown in the classroom using an interactive whiteboard. So student had the opportunity to discuss together and became progressively familiar with concepts and procedures. Experimenting with the ISTAT learning packages helped them to have a clear vision of the statistician work. They became familiar with spreadsheets, with the software statistical functions, with graphs and tables. They used the packages both “inworld” and offline, in the classroom or in the PC laboratory, while they followed a specific training about how to “live” in a virtual world.

In step (2) of the project students, arranged in groups, started to design and to implement a statistical survey concerning topics such as mobile phones, electronic devices, food and free time, following the guidelines to perform a good investigation displayed in Statland. So they planned questionnaires, pre-tested them with a small population sample (about 20 units), then gave them to nine cohorts of student (about 200 observation unit). After collecting data from paper self-completed questionnaires, they analyzed data. In this step students were free to explore Statland from home, to consult materials, to share ideas with other students, and to follow the “state of art” of the project, with or without the supervision of the teacher. This way they had the opportunity to work on real data and discover that variability is everywhere, learning how to measure and model it. These are important steps to evaluate collective phenomena and take decision in condition of uncertainty. On top of that, it is easier to “catch” the attention of the students by concentrating on issues closer to their everyday experience.

In step (3) dissemination of results of their statistical survey took place by posters, by talks in specific meeting organized by the ISTAT institution, or by virtual exhibition areas at Statland. In this step, students were active contributors to Statland contents and were free to upload their multimedia presentations, to build 3D graphs and objects, to set and manage their temporary exhibit areas. They learned how to take snapshots inworld and how to perform the PC screen capture, borrowing the real-time 3D technologies which allow the creation of animated video productions using videogame and virtual world scenarios (*machinima* techniques) [15]. In this way they used the 3D learning objects to realize short videos for e-books about the mathematic bases of statistics such as Frequency, Central Tendency and Dispersion.

The Sistan Community

ISTAT is the most important part of the (Italian) National Statistical System (SISTAN), the network of public and private institutions providing the official statistical information to our own country and to international organizations.

In the Sistan website there is the "Sistan Community", which is a space for discussion and participation for the members of the National Statistical System to actively contribute to the debate about the statistics function. They collaborate and joint projects, propose ideas and share professional experiences. The Sistan Community is divided into thematic sub-communities.

Currently Statland is part of the sub-community called "Sharing experiences between ISTAT and teachers", that was born in October 2014, with the purpose of bringing together ISTAT statisticians and teachers of all school levels wishing to share their experience, discuss their ideas, and collaborate in common projects [16].

Conclusions

This experience has shown the importance of integrating different approaches to learn statistics. There are two approaches to build a virtual environment [17]: (1) it can be built and structured by the teacher, and in that case the student is a simple user with different degrees of immersion; (2) it can be built by students, under the supervision of the teacher.

Statland is the result of a combination of both approaches: architecture, learning paths, most of the educational content are planned and set up by the teacher, while students are both users and active contributors.

Hands-on surveys were also essential for learning: students became actors of their own learning and improved both mathematical and communication skills.

After two years of continuous design and experience, Statland can now provide teachers with training, allow students to share experiences among different classes and schools, and, as a part of the Sistan Community, promote the dialogue with official institutions of statistics. The hope is that the acquisition of basic statistical thinking will help each student better understand their reality and therefore participate more consciously and responsibly in their social life.

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Supplementary Materials:

Media S1: Statland.

(http://www.virtualscience.it/video/PAPER_VIDEO_Occhioni_Michelina_Statland.mp4)._

08.

A Virtual Reality system for an immersive archaeological experience using real data from the Roman site of Piazza Leoni, Verona, Italy.

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Abstract: Porta Leoni is an ancient Roman gate in Verona, northern Italy. Site and landscape were digitally captured with an equipped air-drone (UAV). Photogrammetry allowed the building 3D-model of the archaeological ruins in in real-scale dimensions, with real-world textures and with a realistic physical system; so the interaction and the feelings are almost as the real one. In order to obtain a "real" immersive virtual experience the project was made usable with head-mounted displays, both the more expensive and high-end Oculus Rift DK2 and the cheaper and user-friendlier Android/Google Cardboard; furthermore, starting from the same data, it was created a 3D printed model of the site. This project has enabled us to create and optimize a work flow that permits the 3d digital copy using various techniques (photogrammetry, laser scanning, etc) and the creation of objects in 3D which can then be viewed and / or give rise to immersive virtual environments. The final porting to Oculus Rift HMD state of the art today, and to the mobile world (Google Cardboard), represents a huge and innovative potential and the core of the project. These techniques allow the creation of immersive virtual-reality's environments both on-site desktop pc, both on mobile or remotely.

One Sentence Summary: A work flow that permits the 3d digital copy of entire sites into virtual scenarios for Oculus Rift and Google Cardboard.

Introduction.

We live in a cyber/social era: social networks, virtual communities, 3D virtual worlds, digital/social applications, immersive and collaborative games, human avatars, collaborative experiences, are able to change our perception of the world and our capacity to store, share and transmit informations. Terabyte of digital data are constructing the human knowledge of future societies. The human knowledge is rapidly migrating towards digital domains and virtual worlds.

The idea that a digital simulation process one day could remake the past, or also the reality itself, has stimulated dreams and fantasies of many sci-fiction writers.

Digital interactive activities used in our daily life play an essential role in managing and distributing information at personal and social level. We could say that humans typically interact with different "virtual realities" given the fact that there is a consistent amount of information digitally born and available just in digital format. In the 90s many writers, artists and scholars discussed for a long time on the definition of virtual reality (VR, immersive, semi-immersive, off line, etc.). Nowadays the term is quite blurred and hybrid: virtual realities represent many social diversification of the digital reality and are an essential part of the human life. It is possible to recognize and classify them by technology, brand, purpose, functionality; but all of them are VR, open domains for users, players and developers.

It is likely unnecessary to describe VR at this point because there are too many VR and all of them follow different principles of embodiment and digital engagement: everything could be VR. In the past decades for example VR was mainly recognizable for the degree of immersion and the real time interaction but nowadays the majority of applications are in real time and full immersion is just an option (and sometimes not really relevant). What really changes our capacities of digital/virtual perception is the experience itself. A virtual reconstruction with a wrong code can increase the distance between present and past disorienting the observer or the user and making the models less "authentic".

The issue of authenticity of virtual worlds is quite complex and it is strongly linked with our cultural presence, knowledge and perception. If for instance we perceive the virtual model as fake or too artificial it is because it doesn't match our cultural presence. If we analyze for example the first virtual reconstructions in archeology, and in general, in the 90's, they reproduced mainly empty architectural spaces, without any further social implication or visible life in the space: they were just models. The VR was represented as snapshot of 3D artificial models. So in this sense, cultural presence is a perspective of a past culture to a user, a perspective normally only deduced by trained archaeologists and anthropologists from material remains of fossils, pottery shards, ruins, and so forth. Actually cultural presence should not be a perspective deduced only by archaeologists and anthropologists, but it should be transparent and understood by all. Nowadays an interesting example is represented by 3D games: very sophisticated virtual environments, with a superb graphic capacity to engage players in a continuous participatory and co-evolving interaction, collaborative communication and digital storytelling. They can expand the digital territory they occupy according to participatory interaction. The ultimate scope of a game in fact is the creation of a digital land, world, and situations to "live in" and where to pursue the game's objectives.

In the game context the role of simple users, tipical of the old VR, is transformed in "active players", that is the players themselves contribute to the construction and evolution of the game. These new trends of co-active embodiment and engagement have radically changed the traditional definition of virtual environment/virtual reality as a visualization space peopled by only predetermined models and actions. Now the games are an open collaborative world with specific goals, roles, communication styles and progressive levels of engagement. The narrative of the game can produce the highest level of engagement because serious games, cyber games, haptic systems, are changing the rules of engagement: the use for example of 3D devices such as Kinect as interfaces, open new perspectives in the domain of cyber/haptic worlds and simulation environments. The interaction does not come from different kinds of hardware, but simply by human gestures.

In other words, all the interaction is based on natural gestures and not on a device: the camera and the software recognize an action and this is immediately operative within the digital world. This kind of technology is able to cancel the frame separating users and software, interaction and feedback; in short the focus is not on the display of the computer but on interactions and actions. One day the interpenetration of real and virtual will create a sort of hybrid reality able to combine real and virtual objects in the same environment, as in the recent Augmented reality experiences. This is a necessary premise for introducing cyber-archaeology and the problem of the digital reconstruction of the past.

Unfortunately, this great potential was not systematically used at the beginning for a low involvement of the communities of archaeologists at interdisciplinary level (however with very few digital skills), but also for the difficulties to manage so different sources (most of them analogue) in a single digital environment. A schematic cyber-digital work flow is all-digital: data capturing (digital), data processing (digital,) digital input (from digital to digital), digital outcome (digital data to digital equipments): virtual reality and interactive environments. It is important to consider that cyber-archaeology elaborates data already born-digital: for example, from laser scanners, remote sensing, digital photogrammetry, computer vision, high- resolution or stereo cameras.

Scope of the work

The aim of this work is to create an immersive environment of virtual reality that can afford to recreate the sensations (through the stimulation of the senses of sight, hearing, etc) and the emotions that provides the same real-world environment. This is achieved through the use of complex techniques of digital survey of the real places, the creation of virtual synthetic places, navigable with the latest VR technology (Oculus Rift, Google Cardboard, etc) that allow an immersive and thrilling experience.

During the digital survey it was also explored the use of radio-controlled flying devices (UAV) equipped with digital cameras for photogrammetric survey, a very innovative use for these light remote-controlled aircrafts (drones).

In the phase of implementation of virtual environments is, instead, explored, the use of so-called Games Engine games, such as Unity and Unreal Engine, initially born for the realization of games but suitable, as experienced, to the creation of Virtual Reality, as described in the introduction, both for their ability to use objects and 3D mesh, both for their ease of export to device for VR as those mentioned above.

Finally,, it is also introduced, in the work-flow, the 3D printing technology, experimenting the ease to recreate scale models of reality, using digital data obtained by the methods described above.

All these techniques allow the use and "virtual" fruition of the ancient Roman ruins of Porta Leoni in Verona for educational purposes, tourism, virtual travels for people with disabilities, as a support to other forms of virtual-teaching, etc.

Background of Porta Leoni in Verona, Italy

Porta Leoni is a former Roman port of Verona. It 's not known the name under which it was known in Roman times. In the Middle Ages it was known as Porta San Fermo, for its proximity to the church dedicated to San Fermo but since the fifteenth century was 'called "Leoni" (lions...) for the presence nearby of a Roman sarcophagus with lions (now place behind the monument of Umberto I). The port in the past connected the city with the Cardo Maximus to the Via Hostilia who came from the south and joined Bologna with the city of Aquileia, a city in the north-east of Italy.

Figure 1. Verona's historical city center with Piazza Leoni position (red).

Figure 2. Aerial photo of Piazza Leoni: you could see the Roman's ruins in the middle.

Instead, according to a popular legend, the name comes from a tunnel that leads from this gate to the Arena of Verona, and that was used for the passage of wild animals for gladiatorial shows.

The original door remains only the left side of the inner façade, but allows you to view and analyze the different construction techniques of the Roman gates of Verona.

Figure 3. Piazza Leoni's nowadays.

Figure 4. Porta Leoni's nowadays.

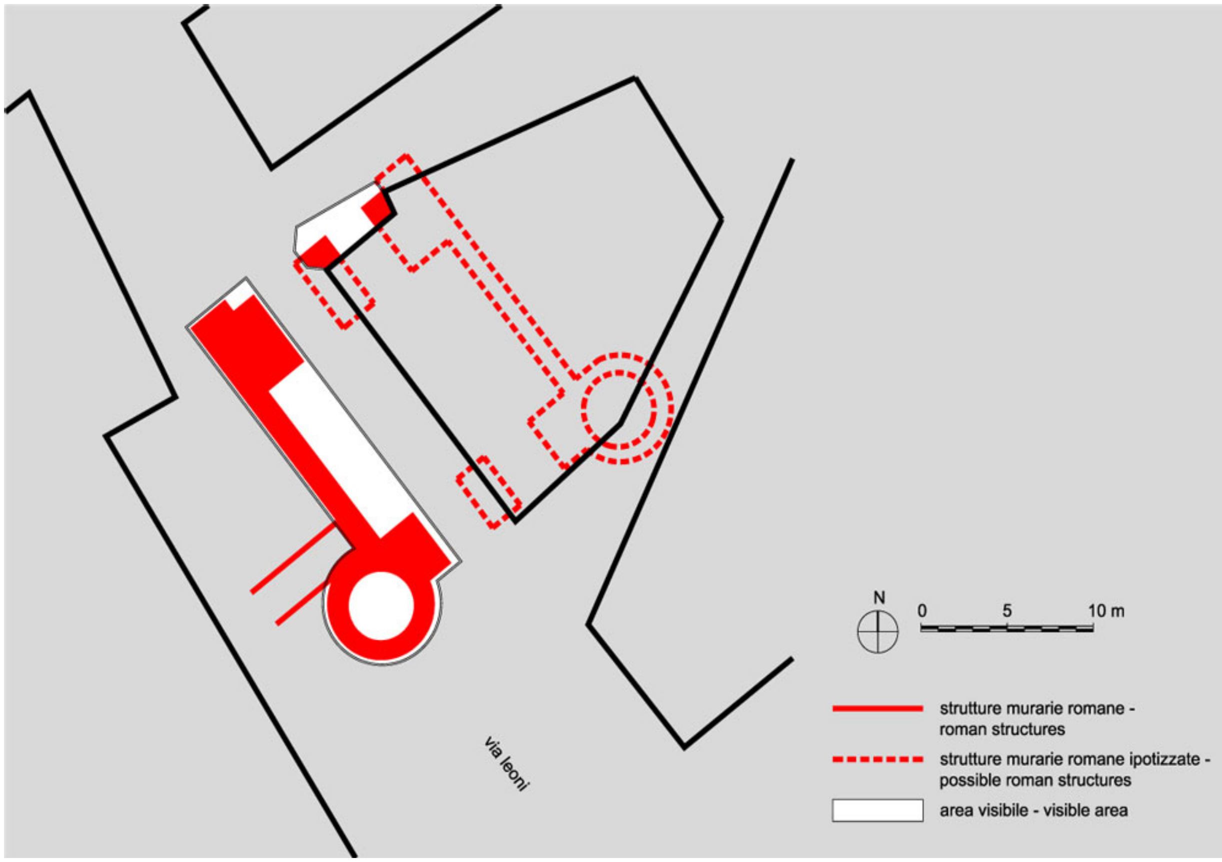

Figure 5. Porta Leoni nowadays: visible and non visible Romans ruins.

The door itself was a kind of small fort, built of brick in the Republican era; during the years of reconstruction of the city in imperial times it was added a white stone façade finely decorated, in fact behind half white stone facade is still visible part of the brick wall of the Republican era.

Some decades ago, during excavations on what was the ancient Cardo Maximus, were discovered the foundations of the missing part of Porta Leoni, and have been left exposed to the public.

The whole complex of walls and doors, for obvious reasons, had a defensive purpose. Porta Leoni, therefore, and the Stone Bridge and all the other monuments of the Republican period highlight the defensive nature. The Lion Gate was built in the Republican era intercession of "quattuoviri" quoted in the epigraph preserved on the facade: "P. VALERIVS / Q. CAECILIVS / Q. VILIVS SER / P. CORNELIVS". It was restored and embellished with white stone, in imperial times (as the other monumental gate of the city, Porta Borsari), according to the inscription, in beautiful characters' lapidary Roman square, carved just above the arch " TI. FLAVIVS. PF NORICVS IIIIVR ID ".

The Door in the Republican era consisted of two terracotta facades with decorations: one facing the outside, the other to the city. They must have identical structures. In imperial age, almost a century after this first door Republican, they build a second thin wall of door marble.

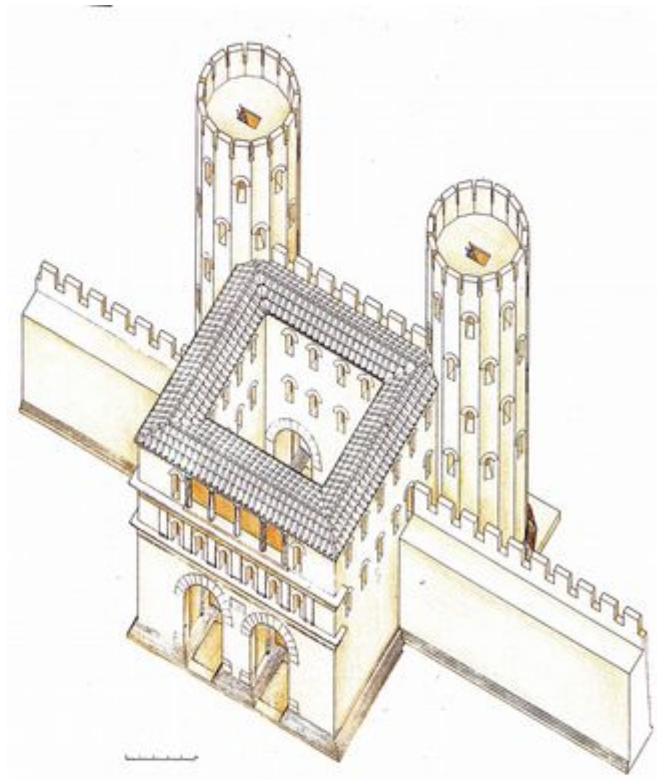

Figure 6. Porta Leoni's simulated reconstruction.

Materials

Digital photogrammetry

The photogrammetry is a technique of relief that allows to acquire metric data of a real object (shape and position) through the acquisition and the subsequent analysis of a couple of frames stereometric. This technique is used in mapping, surveying and architecture.
Currently photogrammetry is one of the techniques of data acquisition of the most reliable, economic and precise.
The term "photogrammetry" was used for the first time in 1893 thanks to Albrecht Meydenbauer, founder and director until 1909 the Royal Prussian Institute for Photogrammetry. In 1924 Otto von Gruber studied mathematical laws applied to photogrammetry and laying the foundations of analytical photogrammetry, that that type of photogrammetry which uses an analytical method, to speed up the process of creating topographic maps.

Depending on the tools (classic or digital cameras, etc) used, the photographic images can be obtained from different distances. Based on this criterion photogrammetry is divided into:

- Micro photogrammetry that finds application in laboratory, by use of stereo images (classic photos or digital) formed with stereo microscopes. Application areas are especially medicine, surgery, natural sciences, physical sciences, etc.

- Close Range Photogrammetry, widely used for the detection of distances from 1m to 30m. Fields of application are the studies for the urban development, structural surveys to create 3D models of buildings and infrastructure, anthropological studies and livestock, judicial investigations, artistic restoration of monuments and sculptures, relief of traffic accidents, etc.

- Terrestrial Photogrammetry, that was at the origin of surveying.

- Architectural Photogrammetry, characterized by a distance between the sensor and the object to be observed of about a few dozen meters.
- Aerial Photogrammetry, (APR) which is realized by mounting the photographic equipment on aircraft. Depending on the extent of the area to detect and scale of representation requested, it flies from heights of 300 meters to 20,000 meters.
- Satellite Photogrammetry, performed by meteorological satellites for the study of the earth's resources.
- Photogrammetry from Drone (also called UAV), which it is realized by mounting different sensors (optical, thermal imaging cameras, multi-spectral sensor, ...) on light flying vehicles.

With the advent of digital cameras of small size (compact or SLR), which can ensure a high standard of quality of the image produced, photogrammetry can be used for the creation of Digital Terrain Models (DTM), orthophoto production and, at the same time, for the architectural survey of infrastructure and buildings for the creation of 3D models.

This last method was exactly the one was adopted for the Porta leoni; it was used a 6-motor UAV with a large payload to take more than 1,000 hi-res photos of the place with a Gopro Hero.

Figure 7. UAV and GoPro used to take aerial photos.

Figure 8. UAV and GoPro used to take aerial photos.

Aerial photographs were supported by filming the same places from the ground, using a digital camera CANON EOS 70D. It was also processed a little topographical network with the aid of SOKKIA advanced total station; it were identified approximately 50 targets, positioned on the floor and on the facades facing the area with Roman ruins.

Figure 9. Topographical network with total station

I also used more than 200 targets (A5 sheet with a unique design) pasted on walls and flooring to give to Agisoft Photoscan "more elements/pixel" to track and to use to build the 3d model.

Figure 10. "Targets" for Agisoft Photoscan.

3D model and Virtual Reality scene

Now I have "raw" digital data of the place, then it is time to work on these to create a real-size, real-textured digital model ot the location. It was obtained through the use of photogrammetric software (Photoscan) that could build a 3d digital model of the reality from photos.

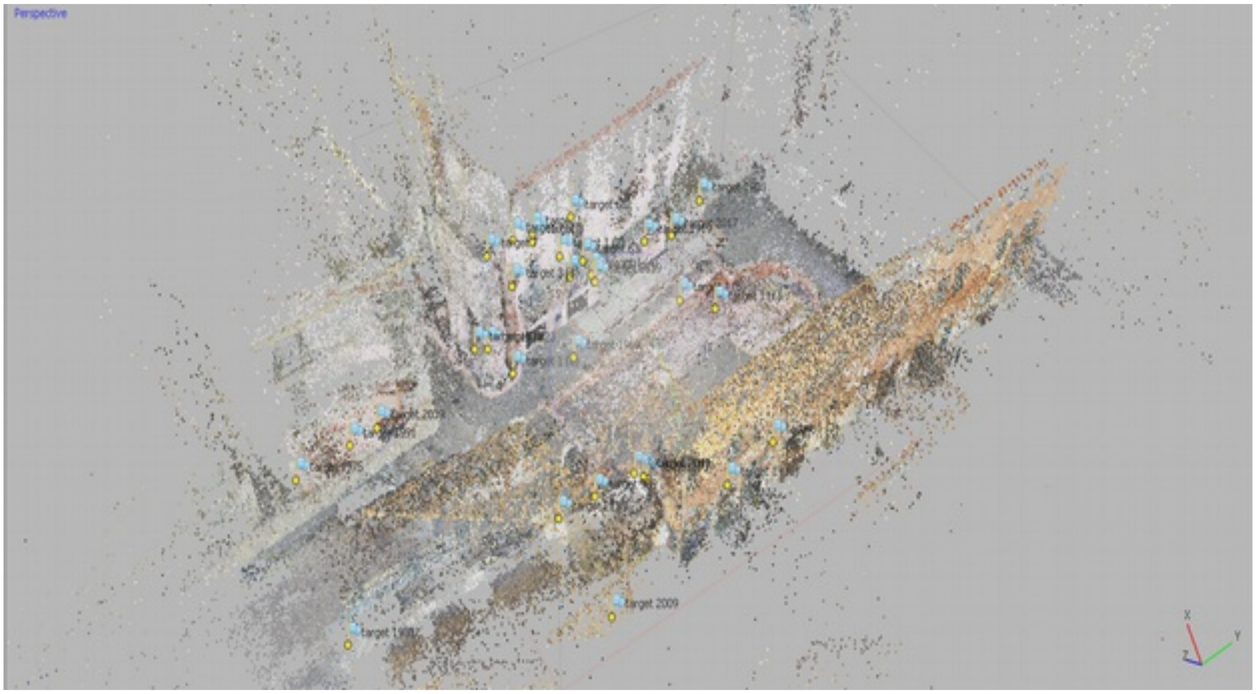

Figure 11. Agisoft Photoscan: points cloud.

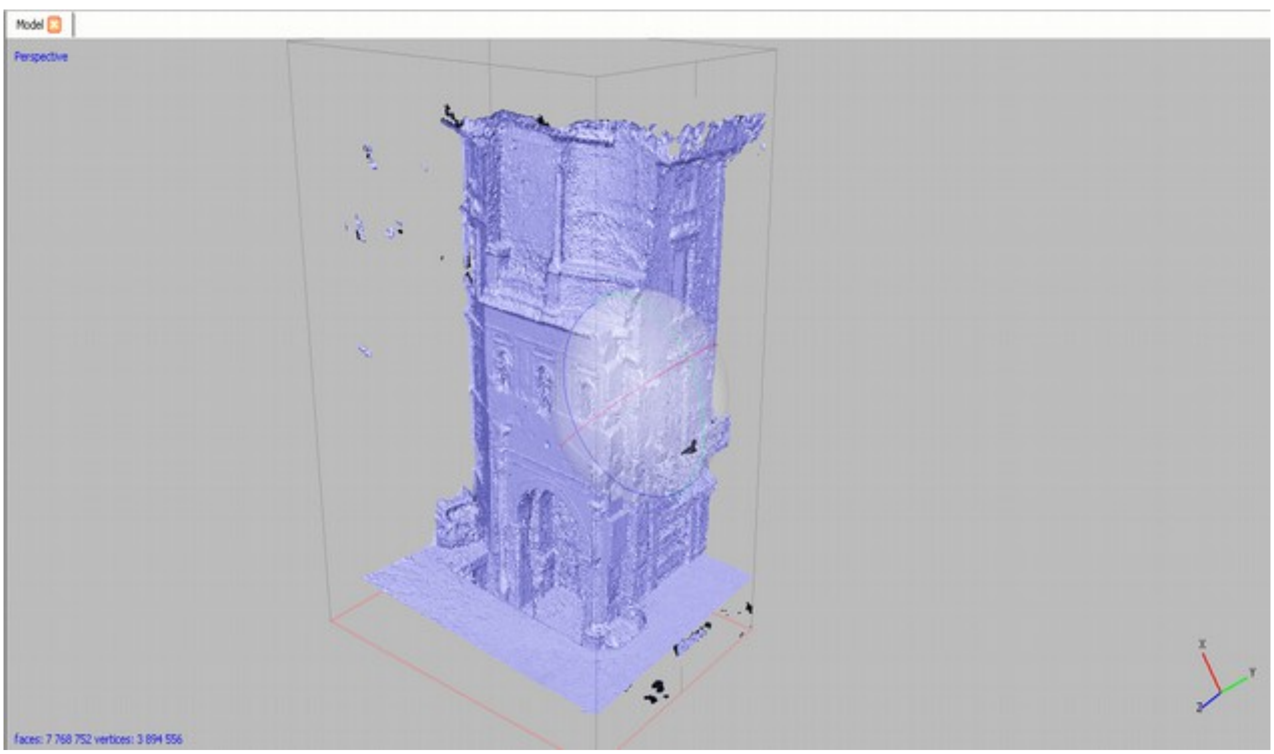

Figure 12. Agisoft Photoscan: mesh.

Figure 13. Agisoft Photoscan: textured mesh.

The raw 3d model was optimized to obtain a low-poly (fast) model suitable to be uploaded into a project in a Game Engine, Unity 3D.

Unity is an integrated authoring tool, cross-platform, for creating 3D/2D games or other interactive content such as architectural visualizations or 3D animations in real time.

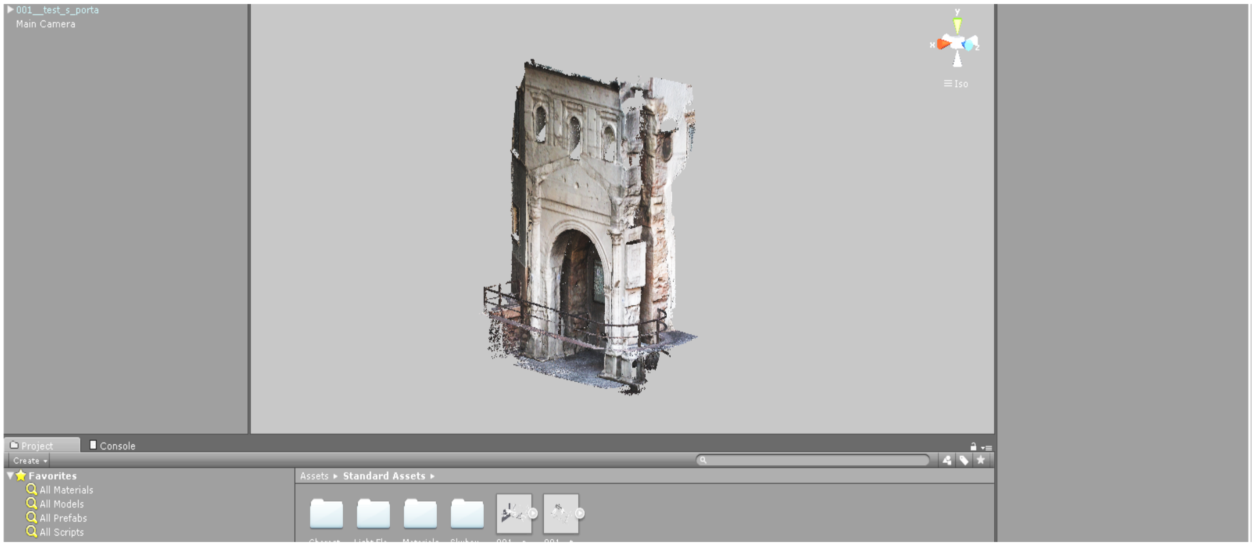

Figure 14. Unity3D: imported object.

The Unity 3D development environment runs on both Microsoft Windows and Mac OS X, and the games it produces can be run on Windows, Mac, Linux, Xbox 360, PlayStation, Wii, iPad, iPhone, Android, Xbox and Wii.. It can also produce games for web browsers that use the Unity web player plugin, supported on Mac and Windows.

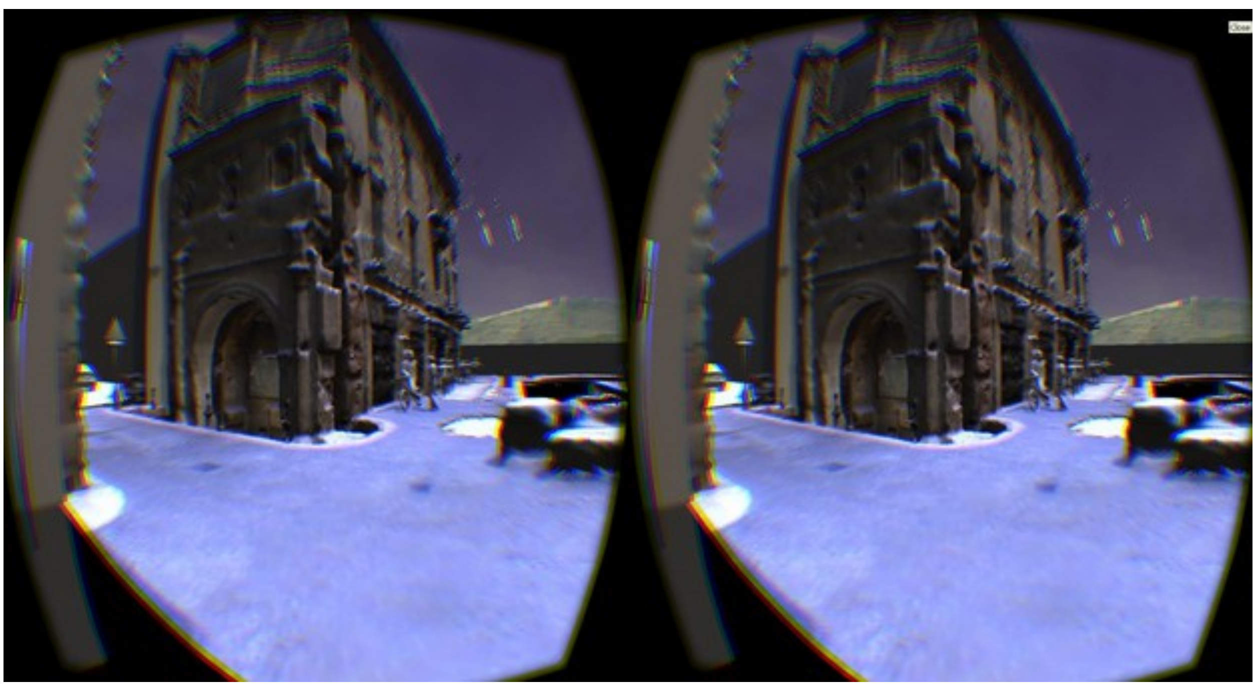

Figure 15. Oculus Rift DK2: Porta Leoni in VR.

Figure 16. Oculus Rift DK2: Piazza Leoni with Ruins in VR.

Unity also has the ability to export games to Adobe Flash, but some features supported by the web player can not be used due to limitations of the same Flash APIs. So you can upload into a Unity project sounds, 3d models, video, photos, voice, web links, use AI to let them operate, interact each-other and with the "player", give outputs, react to actions, etc.

And finally you can publish them on desktops, mobiles, and almost all VR HMD on the market.

For example, I was able to create apps running on Win7 and Android.

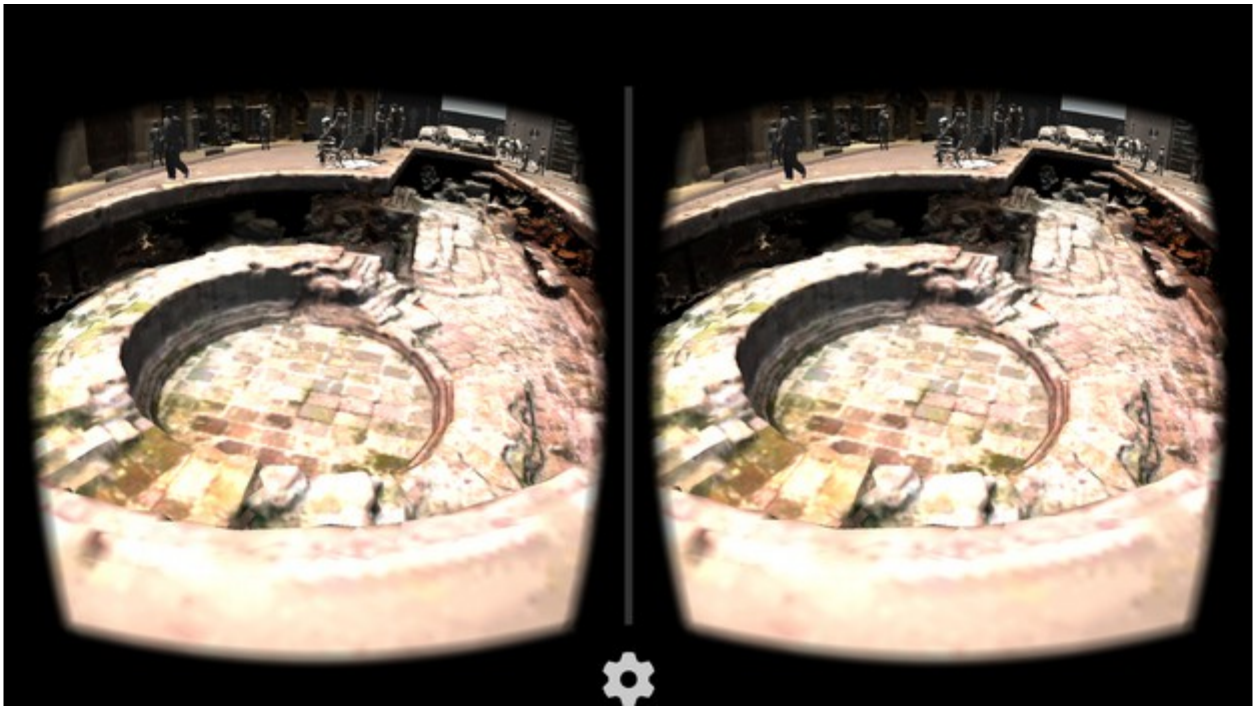

Figure 16. Google Cardboard + Android phone: Piazza Leoni with Ruins in VR.

Figure 17. Google Cardboard + Android phone: Porta Leoni with in VR.

You can understand that Unity (as the others environments, as Unreal Engine, Cry, etc, with the same capabilities) is a very powerful instrument to “link” any kind of digital media to any kind of Virtual Reality headset. It is a true egg of Columbus.

Oculus Rift is a screen to be worn on the face, a Head Mounted Display (HMD) for virtual reality. Its principles and characteristics that make it a cutting-edge device. Developed by Oculus VR, a company that was founded by Palmer Luckey in 2012. The Company was acquired by Facebook for $2 billion in 2014. Palmer, Iribe and Mitchel remained at the head of the Company but Facebook's money could grant a great improvement in research and development of the product. The Rift has a large amoled screen that displays two images side by side, one for each eye. A set of lenses is placed on top of the screen, focusing and reshaping the picture for each eye, and creating a stereoscopic 3D image.

The goggles have embedded sensors that monitor the wearer's head motions and adjust the image accordingly. The latest version of the Oculus Rift is bolstered by an external positional-tracking accessory, which helps track head movements more accurately. The result is the sensation that you are looking around a 3D world. It could be integrated with headphones and positional audio tracks, and you could also interact with 3d 360-space around you with many others devices; for example, through Leap Motion that tracks your hands in the air and use its gestures to perform actions in the virtual space.

During the 2014 Google I / O keynote, Google unveiled its low tech device for virtual reality. This product has been dubbed Google Cardboard for the material with which it was forged.

Just as clearly explains the name is made almost entirely of cardboard, but of course there are some additional parts, as some lenses, some Velcro and magnets. But the most important component is your smartphone, which was added in the middle of the Cardboard horizontally, will become a device for Virtual Reality.

The idea came from David Coz and Damien Henry that during the use of their "20 percent", the time that employees of the Internet giant can use to work on any project they want. The tool was built to help developers prototype VR projects, without having to invest in expensive hardware too. The low cost of the project do-it-yourself comes with a special app dubbed Cardboard. The app works on Android 4.1 and higher, and once installed, all you have to do is put the phone in "device". Once inside, you can close and the application will automatically start thanks to integrated NFC tag inside the box.

With the help of lenses and sensors in the front of the phone will allow you to see the different animations that move. This means that if you tilt your head, you'll be able to see what surrounds you in the virtual environment, thanks to the use of positional sensors integrated into your phone.

The magnets, indicated in the list of components, are placed on the sides of the box and work with the magnetometer of the phone, allowing you to interact with the application running on your smartphone.
The application Cardboard for Android comes packaged with a number of demo applications, such as a video viewer 360 degrees or app of Google Earth where you fly, and many others. The result is impressive, a cheap piece of cardboard could turn your phone into a mobile VR device that could download and run, very easily, VR stunning apps.

3D printing is the evolution of the traditional press. Through a 3D printer you can print real objects, faithfully recreating any three-dimensional model through a 3D modeling program.

With 3D printing, you can then create three-dimensional objects with complex shapes using many different materials which, layer upon layer, are applied to model the desired shape. Generally 3D printers are fast, user friendly and highly reliable.

But basically, what does a 3D printer? It works by taking a file (or model) three-dimensional from a computer, after which creates a series of cross-sectional portions (slices of the object) and “print” one above the other to create a three-dimensional solid figure.

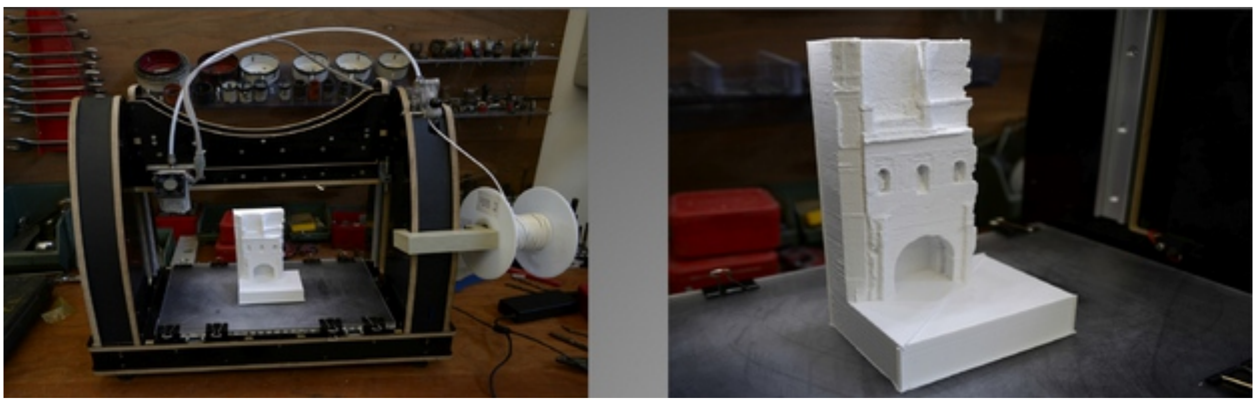

Figure 18. 3d printing process and final result.

Methods

The process followed during the preparation of this project can be so synthesized for points. The macro themes can be summarized in four main points: relief, processing, return, fruition.

These four main steps are divided into sub-phases during which different objectives are sought and used different techniques.

Relief

- Raw survey (tape measure, sketches)

- Photographic survey of maximum (digital SLR)

- Evaluation of critical points

- Planning of the points to be detected with total station

- Survey points with total station (Sokkia)

- Planning of the photographic survey both from ground and from sky

- Photographic survey from the ground (Canon EOS)

- Photographic survey plane (Drone + GoPro Hero)

Processing

- Upload of digital photos in photogrammetric software, automatic straightening, target definition, photo alignment, building dense cloud of points, mesh construction, texture's building

- Mesh Optimization to export to STL (3D printing)

- Mesh Optimization to export to FBX (Unity 3D)

- Import FBX model in Unity 3D and construction of the virtual world, programming, Oculus Rift plugins configuration.

- Export from Unity3D to Oculus Rift compatible project;

- Export from Unity3D to Google Cardboard compatible project;

Return

- Upload of the Android app to the smartphone/Google cardboard combo;

- Preparation of the Win/Oculus Rift code;

- Print the 3D model of Porta leoni

Fruition

- Navigating the Virtual Reality world with Oculus Rift;

- Navigating the Virtual Reality world with Google Cardboard/smartphone;

- Using the scale model of Porta Leoni, derived from 3D printing.

Conclusions

The future of digital archeology is in the interactive process: a continuous work in progress. If in the past the attention was focused on the validation of models, the future of archaeological information is in the digital experience between operators in shared environments and cyber worlds. We could say: "performing the reality" rather than "reconstructing the reality". The virtual performance represents a new digital frame within which the archaeological interpretation can be generated and transmitted. This last phase of digital, born-digital, is completely different: the bottom-up phase during the fieldwork, the documentation process, the 3D modeling produces an enormous quantity of data, whose just a low percentage is really used and shared. Instruments, tools and software of data capturing have increase the capacity of digital recording and real-time renderings, but unfortunately there are not yet adequate instruments for interpretation and communication. The interpretation is hidden somewhere in or through models but we do not have the key for discovering or extrapolating this information from the digital universe. The research work in the last two decades was concentrated more on recording tools and data entry rather than accurate analyzes and interpretations. The result is that too much information or too little have a similar effect: there is no way to interpret correctly. When we analyze for example a 3D model of a place and we compare it with the original, that we take the 3D model is a detailed copy of a real artifact. Is that true? Actually it is not: a digital artifact is a representation of objects simulated by different lights, shadows, contexts and measurable on scale: in other words it is a simulated model not a copy or a replica. Of course there are several similarities between the digital and the real one, but we can not use the same analytical tool. Hands-on experiences on real artifacts to reproduce different feedback if compared with the digital ones. In circumstances some the virtual object has a more 'dense' information, it is comprehensible from different perspectives, but not necessarily reproducible in the real world. The information content of a complex digital representation could be opinions more than authentic: it is hyper-real. This hyper-real archeology elaborates at the end date and much more information than in the past. This new digital phase of research and communication permits to review the entire digital work-flow from data capturing to the final documentation and reconstruction process. The integrated use of different technologies of data capturing and post-processing then generates through more sophisticated pipeline of digital interpretation, thanks to the comparison among models, meshes, geometry and clouds of points. In Additions, the speed of all the relevant digital process is able to increase to the capacities of interpretation to simulate the entire site in 3D. Ultimately tele-immersive archeology is still in embryonic stages of development, but the new cyberspace can potentially generate new interpretations and simulation scenarios never explored before.

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08.

Games Development Using Brain Computer Interface

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Abstract: This paper presents a study on the games applied in the education of people with cerebral palsy using as interface, Brain Computer Interface (BCI). It also looks at the advantages of using games in the learning process. The methodology used was that of qualitative approach and case study. The results presented were the construction of a virtual simulation environment for the application to be developed using the game development tool, Unity3D. At the end we presented the game screens for the teaching of mathematics, which is called NeuroNavegática.

Summary: We can envision a field of study with great chances of success in the educational and workplace area, for disable people.

1. Introduction

The process of school inclusion has been widely discussed in all of its aspects and what has been found is that behind the discourse of teachers who do not feel prepared, it is lack of accessibility and training in the area of digital inclusion that is still very incipient. One solution is to partner with groups and university research projects that can collaborate in this process. The inclusion of people with cerebral palsy is not an easy path, because many of them preserve their cognitive abilities, despite being unable to speak, walk, or even both.

A BCI, acronym for Brain Computer Interface, allows a person to directly transfer commands to a computer. Instead of using a keyboard, mouse or other input device, the user of such interface would simply issue brain wave commands and the computer would respond to these. It is our intention to show here, a solution of learning objects developed with the use of BCI technology.

The use of learning objects may involve concepts and knowledge making use of practical experimentation that would not otherwise be possible. As such, we can simulate educational situations that would facilitate the process of school inclusion of a person suffering from CP. Thus, it is evident that new techniques should be designed within accessibility guidelines, so as to ensure the inclusion of more digital environments. The term learning object generally applies to educational materials designed and laid down in a series of small clusters, in order to maximize the learning situations where this resource can be used. The Institute of Electrical and Electronics Engineers Learning Technology Standards Committee goes even further. According to this institution: "Any entity, digital or non-digital, that can be used, reused or referenced during the use of technologies that support teaching" [1]. An environment in learning objects is a software that has a set goal, in which the student makes decisions that interact with the actions of the actual interaction environment, resulting in a new condition. Learning objects in the form of Digital Learning Constructs (DLCs) are presented as an Assistive Technology (AT), which offers prosperous contributions towards the development of applications intended for teaching. "For people without disabilities, technology makes things easier. For people with disabilities, technology makes things possible" [2]. Already Cook & Hussey define the concept of AT quoting the concept of ADA - Americans with Disabilities Act - as "a wide range of equipment, services, strategies and practices designed and implemented to reduce the functional problems encountered by individuals with disabilities" [3]. The Comitê de Ajudas Técnicas - CAT [Technical Help Committee], of the Ministry of Science and Technology of Brazil, approved and acknowledged this new concept, on 14 December, 2007, as follows:

> Assistive Technologies. Area of knowledge, of interdisciplinary features, which encompasses products, resources, methodologies, strategies, practices and services that aim to promote the functionality related to the activity and participation of people suffering from disability, impairment or reduced mobility, in search for autonomy, independence, quality of life and social inclusion.

Among the assistive technologies applicable in the context of this work, we highlight the digital games, which are currently also regarded as a new form of language, given that they can turn traditional content into new interactive content and communicate these in a more efficient and innovative manner. This is a concept that is known as gamification, which allows for the creation of simulations with the aim of training professionals, as well as being an aid to student learning According to Zichermann and Cunningham [5], both purposes are correct and thus define gamification as being the use of game thinking and game mechanics in a non-game context to engage users in solving problems or achieving a said goal

1.1. Cerebral Palsy

Cerebral palsy (CP) or non-progressive chronic encephalitis (NPCE) in children is a disorder that affects movement and posture, and comes as the result of an injury to the immature brain in the prenatal, perinatal and postnatal periods [6, 7, 8, 9]. In 2006, Rosenbaum, Paneth, Leviton, Goldstein, Bax, Damiano, Dan and Jacobsson [10], came up with a definition that described cerebral palsy as a group of permanent disorders in the development of movement and posture, attributed to non-progressive disturbances that may have occurred during foetal or infant development.

Children affected by Cerebral Palsies have a disturbance in the control of their postures and body movements as a result of a brain injury. These injuries are the result of several causes. The most frequent is linked to the lack of oxygen flow to the brain, occurring either during or immediately after birth.

1.2. Game Characteristics

All games share four characteristics, which define them: target, rules, feedback system and voluntary participation [11]. The target is the reason that justifies the player participating in any of the activities; in other words, the element by which the participants of a game concentrate their attention in order to reach the set goals. The feedback system advises players as regards their relationship with the various aspects that regulate their interaction with the activity. This system is also responsible for encouraging motivation, also keeping participants aware of progress as regards themselves and their target [11].

1.3. Brain-Computer Interface – BCI

The first BCI was described in 1964 by Walter Grey, when he implanted electrodes directly into the motor area of the cortex of a human patient. The experiment consisted of recording the patient's brain activity as he pressed a button. This action would make the slides of a projected slide show to move forward. Then the scientist developed a system that would make the slides advance whenever the patient's brain activity indicated that they wanted the button to be pressed. Interestingly, besides testing the equipment and checking its effectiveness, he also discovered that there was a need to input a small delay in presenting the slide show, as the slides were advancing slightly ahead of time of the button being pressed [12].

According to [12], until the 90s, progress on the study of BCIs was slow. For example, in the early twentieth century, there were around 10 research laboratories, on a worldwide scale, that were devoted to this study. However, there was a rapid growth over recent years regarding research on BCIs and there are currently more than 100 related research projects worldwide. However, the most important aspect is that this area of research was able to prove that it is able, not only to rehabilitate, but also extend the capabilities of human beings. On the other hand, BCIs are not yet completely conventional, they are not easy to use and as such, there is still a need to improve systems.

A BCI provides an alternate means for natural communication of the nervous system; it is an artificial system that surrounds efferent pathways of the body. It directly measures brain activity associated with the user's intention, and translates into application control signals. Typically, it has four characteristics: it must record direct brain activity; it must have feedback; it must be in real time; and should be controlled by voluntary initiative of the user [12].

Wolpaw [13] states that the brain-computer interfaces (BCIs) are a fundamentally new approach to restore communication and control to people with severe motor disorders, such as Amyotrophic Lateral Sclerosis (ALS) and spinal cord injuries as well as other degenerative diseases. And he said, in 2007, that it could be an excellent assistive technology.

Schuh, Lima, Heidrich, Mossmann, Flores and Bez [14] developed a study and prototyped simulator of a wheelchair in a three-dimensional environment controlled by non-invasive brain-computer interface. To this effect, we used a low cost EEG, NeuroSky Mindwave (MW), as a signal acquisition device. For the development, we used Unity3D, a games engine. Through the prototype developed, we were able to detect blinking, and thus use this feature as a command for the simulator.

The human mind cannot be understood without a study of the brain, which is the responsibility of neuroscience, hence the study of brain and mind in the complex area of the project, is only possible through Neuroergonomics. Neuroergonomics can thus provide more effective and natural interaction between man and technology.

1.3.1. Operation

As shown in Figure 1, one can find that:

a) The process begins with the user's intention;

b) The intention to communicate or control something triggers a complex process in certain areas of the brain;

c) The activation of certain areas of the brain causes a potential difference with the adjacent areas.

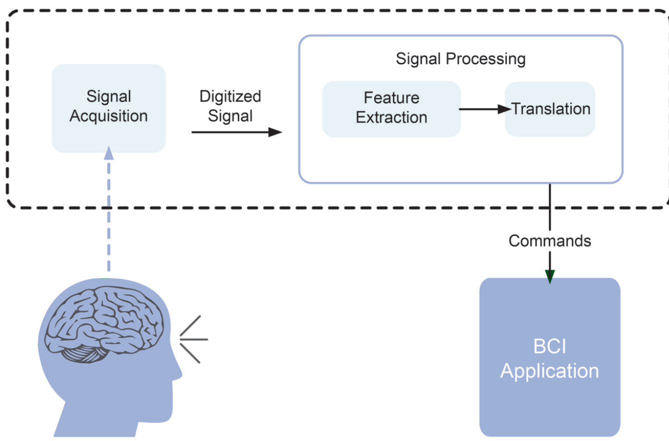

Figure. 1. BCI Diagram

1.3.2. Neurosky Mindwave Mobile

In the experiments we will use the NeuroSky MindWave (MW). NeuroSky is a company that was founded in 2004, in Silicon Valley, and which is focused on developing BCI devices. MW is a portable EEG machine that currently costs USD 129.90. In general terms, this machine can record brain waves, process the information and scan it. It then makes this information available to the used in applications [15]. The rhythms, frequencies, and conditions or mental states considered by the manufacturer are shown in Table 1.

This device is based on the Neurosky Thinkgear Technology, which consists of an electrode positioned in the Fp1 region, an electrode as point of reference in the ear clip, and an inside chip that processes all data as well as removes noise and interference. The device features a proprietary algorithm called eSense. It is through this that some features are extracted from the scanned signals, providing some alternative commands directly in the applications. One can for example, quote the attention and meditation levels [15].

Hence, among its features, the Mindwave implements the algorithm that recognizes the blink of an eye. This way, it is capable of measuring the force with which the blinking is performed, passing this information in integer values, which can vary from 1, for a slight blink, to 255 for a strong blink. With this, we chose to use this feature as a command for the game.

2. Pilot Study

Here we present a comparative study among people with cerebral palsy and ordinary people, of different ages, using a Brain Computer Interface equipment (BCI). This study was conducted with people from Portugal and Brazil.

The objectives were:

• To develop a study to evaluate a product in order to understand whether people with cerebral palsy could interact with the computer;

• To compare if the performance of people with cerebral palsy is similar to the performance of ordinary people when using the MindWave brain-computer interface by Neurosky;

• To understand what emotional experience result from using the MindWave;

• To understand whether there are any differences between using MindWave by people with cerebral palsy and, ordinary people;

• To understand the main limitations of MindWave when used by people with cerebral palsy.

2.1. Methods and Materials

• The research was of a qualitative approach. To develop the research we chose the case study. We justified our choice because the case study is an in-depth, multi-faceted research of a unique social phenomenon. We worked with Observational Case Studies. Stake [16] suggests that the case study is the study of the particularity and complexity of a case in understanding its activities within particular circumstances.

• Both people with cerebral palsy and ordinary people in both Portugal and Brazil were assessed.

• The purpose of the study was explained to all participants.

• Before each game there was an explanation of the purpose and mode of interaction (Attention/Meditation).

• The participants with CP performed the test individually in the presence of two researchers and one AFID occupational therapist, in Portugal. Ordinary participants performed the test individually in the presence of a researcher.

• In Brazil the participants were patients with cerebral palsy from the physical therapy clinic of Feevale University and the ordinary people were undergraduate students from the same university.

Participants tried out four games in the following order:

1. “Burn” Game
2. “Float” Game

3. “MindAnt” Game

4. “Jack Adventure” Game

In the Burn game, the subject must concentrate on making a barrel explode. When reaching the attention level needed, the barrel explodes and times are recorded. Following the explosion, the barrel is burned again, whereby one can always improve times. Three attempts are made and the times are recorded. In the Float game, the levels of relaxation are measured. Unlike Burn, here it is necessary that the subject is relaxed to achieve the goal, by making a ball levitate to its highest and for the longest possible time. Three attempts are made and the times recorded as well as the height (in metres) of each attempt.

The MindtyAnt is a game where the user focuses its attention levels to help an ant push a piece of food into the ants nest. There are 16 levels that challenge concentration skills and user timings, combining mental control with the use of a keyboard. For the tests, three attempts are carried out always at the first level of the game (where only mind control is used i.e. no keyboard), and times are recorded. In the last game, Jack’s Adventure, the objective is to reforest other planets. Jack is the main character, who travels through space with his spaceship to help alien friends tackle environmental problems, such as air pollution and sandstorms. In each new stage of the game, the required levels of concentration increases in order to make Jack plant the trees. In this game, the user plays until they cannot pass a first level game. Times are recorded for each level where the user passed onto the next without losing.

2.2. Population

Table 1 presents the population of the study.

	Controls		People with Cerebral Palsy	
	Brazil	Portugal	Brazil	Portugal
Median	25,8	39,5	11,8	38,5
Minimum	3	19	3	23
Maximum	36	76	20	50
Standard deviation	7,24	14,13	5,39	9,2

Table 1. Sample population age in Brazil and Portugal.

We noted that the task execution time was similar between the populations of both countries. The major difference in executing the first and second, was in particular related to Burn and Float. Float was regarded as the hardest, given that it pertains to the brain wave called meditation and/or relaxation, unlike the others whose brainwave is attention. There were no cases of a participant of the research not having enjoyed the experience. We found that when the level of attention was deviated in games where a higher attention level was needed in order to pass the level, this level lowered. This proves that the many activities undertaken at the same time lowers one’s level of concentration. Thus, we agree with Yasui [17] who conducted a survey using the BCI sensor while the user was driving a vehicle. Hence, specifically when driving a vehicle, the records showed an obvious pattern change when a cell was introduced.

There are no significant differences among people with cerebral palsy between the two countries and also between populations without cerebral palsy from Float games, MindtyAnt and Jack's Adventure.

In terms of the physical design, the MindWave headset satisfies around 87.9% of the population, however improvements can be implemented so that adjustment to different percentiles can be made more effective. The experience in using this product is quite positive from the tests studied.

In the pilot test, we found that the MindWave product fulfilled the function for which it was intended, having revealed that even within certain population niches, such as the case of people with cerebral palsy, its function is confirmed. BCI devices can be great allies to the adaptation of interfaces capable of being used by most people without requiring the use of movement for the control of elements or tools.

3. Results

With the end result of constructing a virtual simulation environment for the application under development, we found that to this effect and for the development of games, the Unity3D tool gave us the opportunity to create such an environment.

Unity3D is a Game's Engine for developing 2D and 3D environments. The tool came into the market with the purpose of democratizing the development of games

A focus point is its integration with other tools, such as the 3DS Max, Blender and ZBrush, in addition to plug-ins that can be developed by the user. It has multi platform support, including Windows, Mac OS X, iOS, Android, and others. For the development of applications, it can be natively executed in C#, JavaScript and Boo languages (Unity3D). For the execution of scripts, it has a high performance version of the Mono Library, an implementation of the open source framework .Net Microsoft [18].

Another contributing factor is the C# language support, with the available libraries of Neurosky it becomes compatible with application development. Available in two versions, a paid version, which costs USD1500 and has the name of Unity3D PRO, and a free version, called Unity3D. It can be installed on Windows and Mac OS X [19].

The game developed is called NeuroNavegática. All game menus use the keyboard, mouse or a touchscreen device such as interface. As shown in Figure 2, we chose maths:

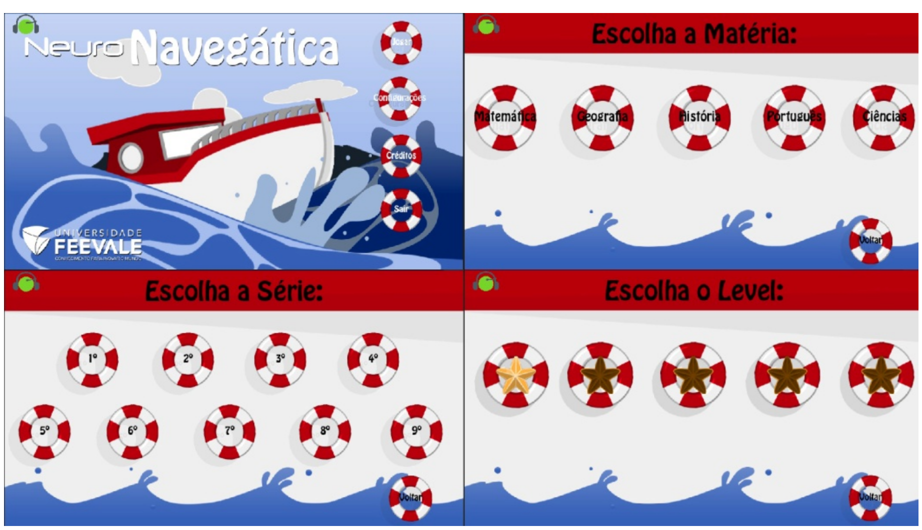

Figure 2. Start keys of the Neuro Navegática.

In Figure 3 is shown the gameplay. In the first part, the user controls a diver in a challenge, in which the goal is to jump to the bottom of the sea without hitting any of the fish that are passing by. By finding the best time to jump, the user blinks their eyes. At that moment, the diver shall jump. Should the character hit the fish, time is deducted from the next part of the gameplay. When completing a challenge, the user gets a screen with a question, four answers, of which only one is correct, and a maximum time limit in which to answer the question. Each answer has its corresponding chest on the screen. These chests are automatically shown by the application. The featured chest lasts a certain amount of time, until it moves onto the next chest, and so on and so forth. When the user wishes to select a chest, they must blink their eyes. In selecting a chest, the answer to the question will be checked, and feedback given to the user.

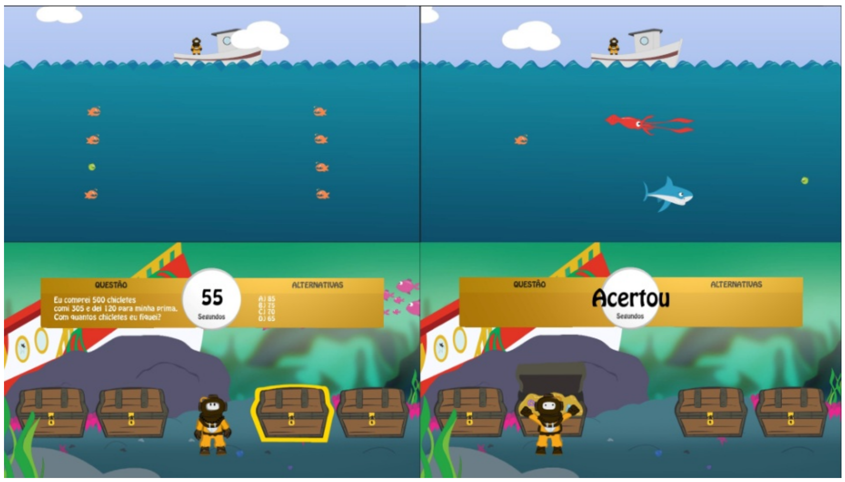

Figure 3. NeuroNavegática game screens.

At the end of the gameplay, the message is shown, advising the user that the next stage shall begin automatically. This way, there is no need for intervention of another interface in order to pass all levels of a given subject, in a given series.

4. Conclusions

In an overall analysis of the MindWave product, as a communication interface for games, we found that the product fulfilled the function for which it was intended, having revealed that even within certain population, such as the case of people with cerebral palsy, its function is confirmed.

[PARÁGRAFOS PRATICAMENTE IGUAIS]

The BCI technology provides a means for interacting with machines, products, systems, and as such its study, is of great importance, because on the one hand, through BCI it is already possible to adapt machinery, products and systems to people with mobility problems to improve their performance, thus turning disabilities into mere differences of execution, but with similar average performance to that of ordinary people. On the other hand, the study of BCI ergonomics allows for analyzing levels of mental burden, instantly and objectively. By analyzing this new data, researchers in the area of ergonomics, can understand in a more objective manner, what are acceptable levels of burden for mind tasks, control the onset of fatigue, minimize the occurrence of errors that may result from decreased attention levels, and other aspects that may emerge. Thus, we can use the brain functions towards the designing of safer systems, more efficient operations and on the other hand, we can advance in understanding the brain functions in relation to procedural and cognitive performance on tasks that one may be asked by the outside world.

In performing the first step of the research at the University of Lisbon, we applied pre-tests and concluded that people with cerebral palsy, regardless of their age, presented similar or equal results to ordinary adults. After applying the tests in Brazil, we observed very similar results. Thus, we envision a field of study with great possibilities of success in the area of education and also in the working world. We also observed that in the various groups of researchers from prestigious universities there was no publication to show the research conducted with people with cerebral palsy and BCI.

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09.

Developing Spatial Ability and Digital Fluency via 3D Game Programming and 3D Printing

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Abstract:

Spatial ability has been found to condition the choice of the science majors, on one hand, and to differentiate between the genders, on the other hand. Mental rotation tests demonstrated the relation of spatial ability to digital fluency, still influenced, in its turn, by digital divide. This research allows us to create DigitPrep, a method based on 3D game programming and 3D printing, for training spatial ability and developing digital fluency of middle school girls from underserved school districts during a summer program introducing subjects to STEM fields. We explore the impact of such fun kinesthetic activities as 3D selfie production using mixed reality app and 3D printing, on improving spatial ability of the students. Non-computer based 3D activities are compared to and combined with the impact of surrogate embodiment in Alice 3D game programming environment on spatial ability and digital fluency of the students. Digital fluency is essential for access to online resources. We earlier demonstrated by means of logistic regression that students with higher scores in digital fluency find educational virtual environments easy to use, and useful, more often than less digitally fluent subjects do. Thus, we recommend DigitPrep method for orientation training preceding any educational programs that require usage of online learning materials.

One Sentence Summary: This study introduces DigitPrep, a method based on 3D game programming and 3D printing, for training spatial ability and developing digital fluency, thus engaging in particular underrepresented students and increasing their access to STEM fields, preparing them to entering higher education, and succeeding in chosen careers.

Introduction

L'espace est comme la trace laissée derrière elles par

les activités intellectuelles et cognitives du sujet (J. Piaget [1])

[Space is like an imprint left behind by the intellectual and cognitive activities of the subject]

Spatial ability is a psychometric measure of cognitive processes by which spatial objects and their relationships are mentally represented, manipulated, and recalled. Just and Carpenter [2] in 1985 suggested that subjects high in spatial ability were faster and more flexible in performing the mental rotation tasks compared to participants with low spatial ability. The importance of spatial ability as a pre-requisite for learning and success in such specialties as mathematics [3], engineering drawing and graphics [4, 5], science education [6, 7], and in STEM subjects in general [8] arises the question about the possibility for the spatial skills to be trained.

2013 meta-analysis of 217 spatial ability training studies [9] demonstrated that spatial ability training effects were stable, not affected by the delay between training and post-testing, and transferrable to other spatial tasks which were not directly trained. However, some evidence suggests that spatial ability effects do not always transfer to other domains. For example, a research on Tetris video game players suggested that spatial expertise was highly domain-specific and non-transferrable broadly to other domains [10].

Both kinesthetic training (learning by doing), and virtual training of spatial ability were proposed in research literature. Kinesthetic activities, according to embodied cognition, can serve anchors for understanding, by connecting bodily experiences to abstract concepts [11]. Dr. Black at Columbia University [12] showed the role of kinesthetic presentation format on mental model acquisition: when learning Newtonian mechanics with an animation game, as the systems became more complicated, students who directly manipulated the animation outperformed those in text-only groups and text-and-static-visuals groups on the outcome measures, recall, model-based reasoning, and transfer.

Specific studies were dedicated to the possibility of indirect training of spatial skills. Thus, spatial visual abilities (SVA) were found to improve after taking introductory physics. Although students who withdrew from the course demonstrated mathematics skills comparable to those of students who completed the course, their scores on perception tests were appreciably lower [13]. Subjects' spatial ability was found to improve after using a Web-based Virtual Environment (VE) [14].

The effects and interaction of spatial visualization and domain expertise were demonstrated on information seeking: Downing provided evidence in support of interface designs that are friendlier to information seekers who have low SVA [15]. Learners with low spatial ability are better supported by a moving than a non-moving illustration as well as by 3D instead of 2D modeling [16]. "Specifically, spatial visualization ability (SVA) seems to be particularly related to hierarchical menus systems navigation within databases, online learning environments, information archival systems, and virtually all internet web sites" [15]. Mental rotation tests demonstrated the relation of computer and videogame usage to spatial ability [17]. Additional research suggests that high levels of spatial ability are related to digital fluency [18]. Thus, acquiring digital fluency can be considered as tactical learning that requires spatial ability.

"One's capability, competence or skill of using [digital] technology" can be described as digital fluency [21]. Digital fluency is essential for the students' access to educational eResources. Research suggests that students with greater digital fluency make better use of online materials and do better in their classes that use those materials [19]. One of the wide scope studies using scored tests of real skills, conducted in 2011 [20], found that gender, age, education, Internet experience, and hours online contributed to medium- and content-related Internet skills. Another way of looking at student differences is to consider age, where those born in or after 1980 are known as "digital natives", and those born before 1980 are called "digital immigrants". A study on the differences of student use of digital technologies in college, depending on their age [22], showed that students only use a limited range of technologies. When confronted to the learning technologies at college, students' attitudes appear to be influenced by lecturers' teaching approaches. As suspected," digital natives" used more technology tools compared to "digital immigrants".

Digital literacy, as discussed in the research literature between 1990 and 2010, was considered to have such dimensions as technical, cognitive (information literacy, photo-visual, audio, spatial), social-emotional (critical, netiquette, cybersafety). The American Library Association's Digital Literacy Task Force defines digital literacy as the ability to use information and communication technology to find, evaluate, create, and communicate information [21]. Some researchers even call for acknowledging a new digital intelligence that should be added to Gardner's multiple intelligences [23, 24].

In a study of undergraduate students introduced to an eLearning course, carried out using not only self-reported performance but also scored tasks of design and construction with new technologies [22], it was demonstrated that the undergraduates are generally able to use unfamiliar technologies easily in their learning to create useful artifacts. They need, however, to be made aware of what constitutes educational technologies and be provided with the opportunity to use them for meaningful purposes. For example, students may not spontaneously use discussion effectively, and that collaboration, especially among those still learning its forms, is facilitated by appropriate amounts of structure [25]. Also, Hanlon study demonstrated that reported by the students DF was different from the factual DF, measured by scores in DF tests and performance in real tasks [26], that's why the practical tests are preferable to the self-reported performance when studying digital fluency.

The self-perception measures of the Ng's study indicated that digital natives can be taught digital literacy [22]. This suggests that educating young people in using technologies helps them to develop their digital literacy, which may then lead students to be more flexible and innovative in their use of new technologies for learning.

Yet with the fast development of information technologies and their widespread use in the everyday life, it makes sense to talk about the degrees of digital fluency, rather than digital literacy, as nowadays it becomes increasingly difficult to find an individual who has never used a computer, and children learn to use a word editor in primary school. The chief difference in digital fluency is a person's understanding of the core concepts that will help him or her to successfully learn and use new technologies as they become available.

Scope

Model

Suggested method of spatial ability (SA) and digital fluency (DF) training was developed for the two-week summer camp program followed up with a series of Saturday programs held twice a month.
Program allows the students to get familiarized with Augmented/Mixed/Virtual Reality and grasp basic concepts of object oriented and event driven software programming. During the first week, students follow a traditional computer literacy training, and then participate in such non related to computer programming activities as green screen imaging and scanning, editing, and reproducing of a 3D printed character to take home.

By the end of the second week, every student creates her own 3D animation in Alice virtual game development environment, and turns it into an augmented reality show using a smartphone application.

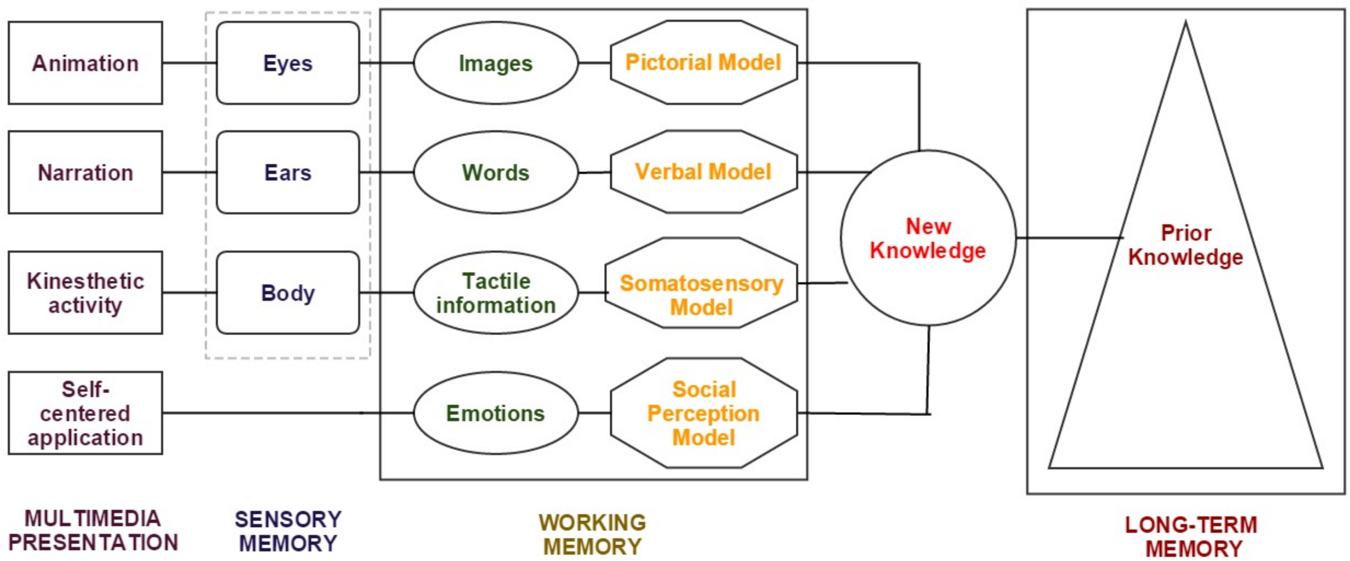

Figure 1. Model of the spatial ability and digital fluency training using 3D printing and programming (based on the Cognitive model of Multimedia Learning by Mayer & Moreno [32] and its development by Dr. Black [12])

This research is designed and developed in order to verify the following hypotheses:

- DF is better trained using surrogate embodiment (3D programming) and kinesthetic learning (3D media objects creating and producing) than 2D traditional training
- SA can be trained using kinesthetic learning (3D media objects creating and producing)
- SA can be trained using surrogate embodiment (3D programming)

Method

Participants

A cohort of 25 6th grade young women was introduced to practical aspects of computing through a two-week summer day camp. The age group was chosen because continued achievement and a foundation of eventual success in the sciences starts early in a student's education.
Piaget have distinguished four stages in the development of spatial cognition [1]. During the formal operational stage starting at the age of 13 a child becomes capable of mental manipulation involving spatial possibilities of an adult.

Figure 2a. Picture of the TechPrep cohort in front of the Computer Science building

Figure 2b. 2015 cohort of TechPrep in class

Procedure

Before the program and after each week subjects took digital literacy test and spatial ability test. During the first week, students took a traditional digital fluency training including computer simulations, text and videos. After the second digital fluency test, students were experimenting with

Virtual Reality and making 3D selfies in the Media lab, then participated in Innovation Lab workshops on 3D printing and on using the app BlueScreenIt for green screen picture taking;

Every day of the second week the class was working in randomly assigned groups, so that

1) part of the class works on Alice 3D programming environment in computer classroom;

2) second group scans 3D selfies in Media Lab, editing the taken selfies, and experiences Occulus Rift VR.

By the end of training, the two groups made presentations and used the smartphone app Aurasma to make coded by the girls 3D Alice world videos come to life, triggered by the green screen pictures. (see detailed curriculum in Appendix 2)

Learning materials were uploaded online in a virtual learning environment (Blackboard Course Sites' MOOC). Blackboard treasure hunt was timed in order to find out whether higher digital fluency or spatial ability facilitated easiness of use of virtual environments [17].

Figure 3a. Innovation Lab

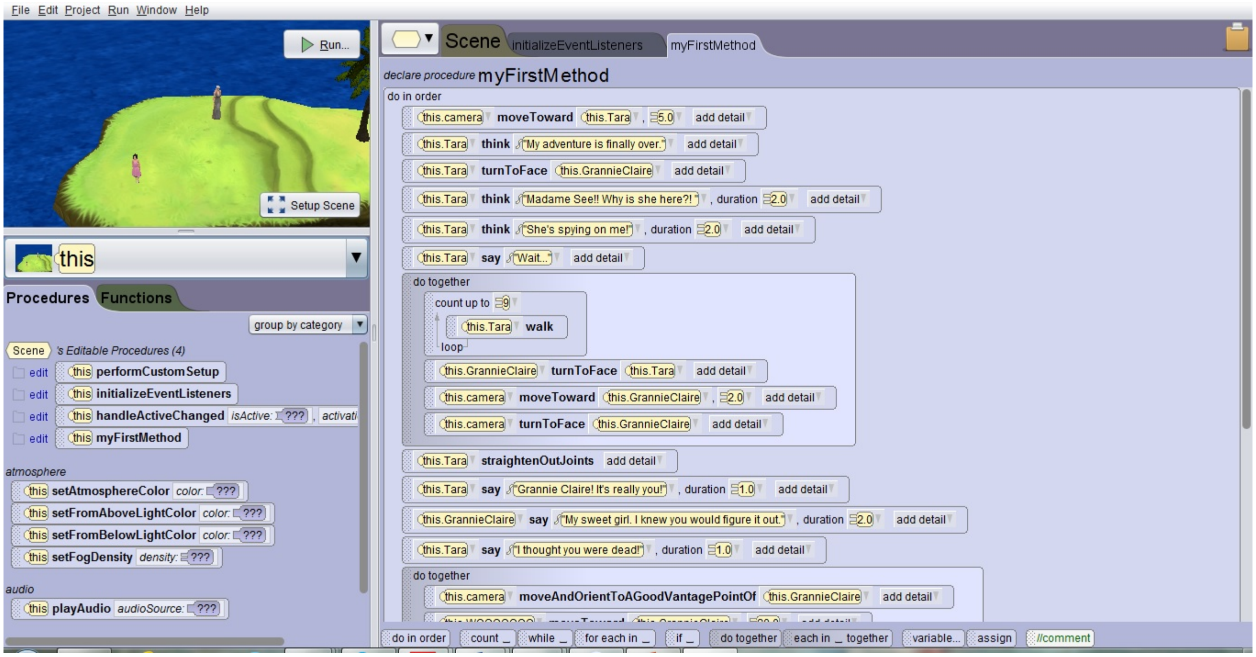

Figure 3b. Alice environment Code editor

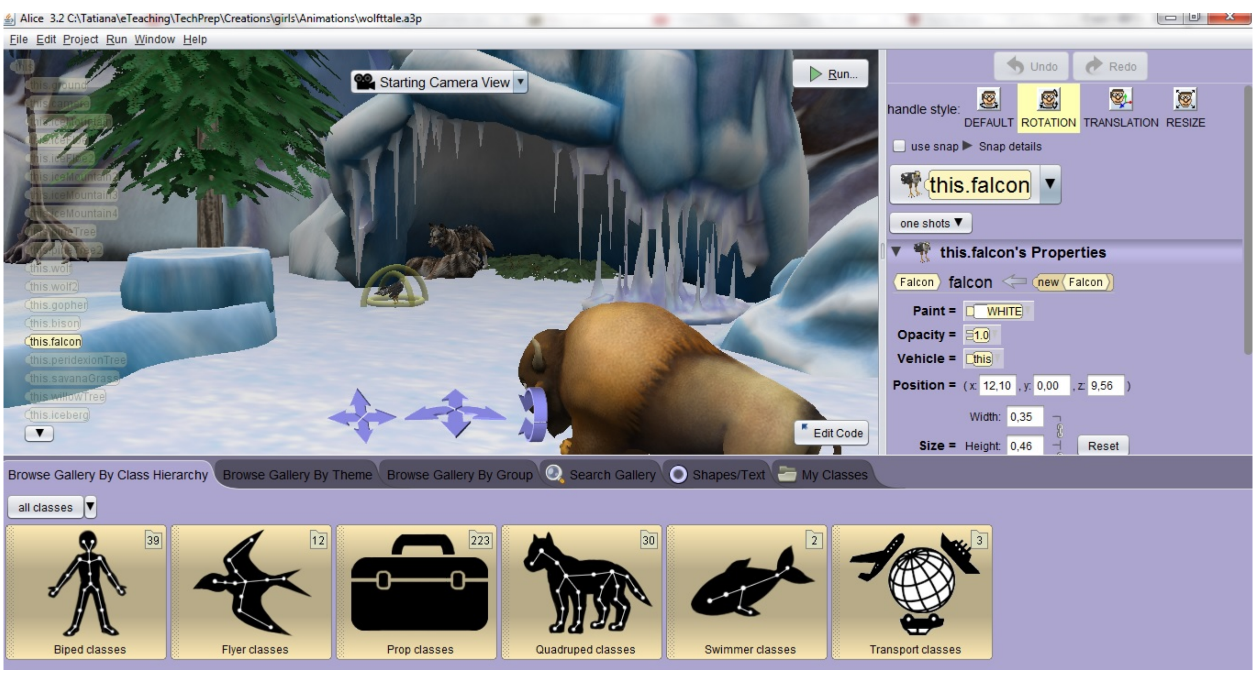

Figure 3c. Alice environment Scene editor

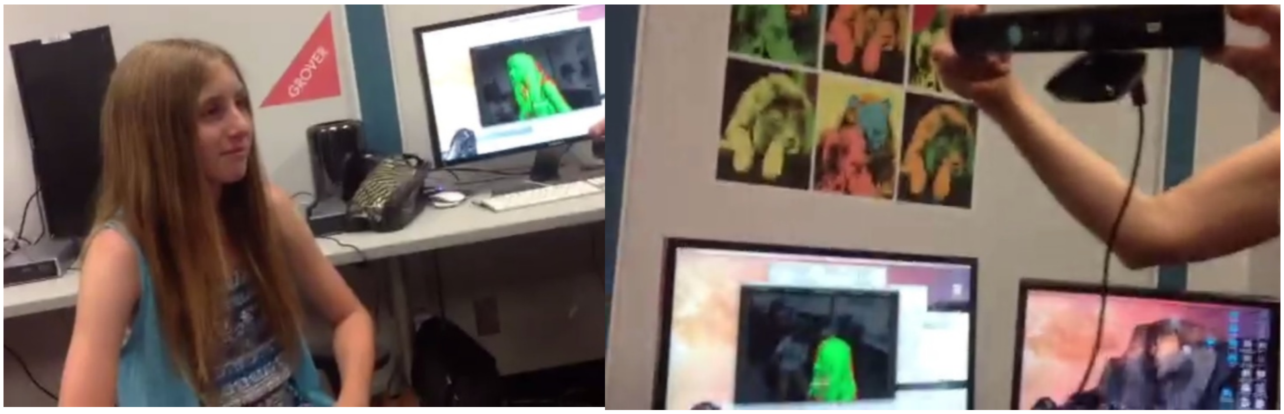

Figure 4. Scanning 3D selfie

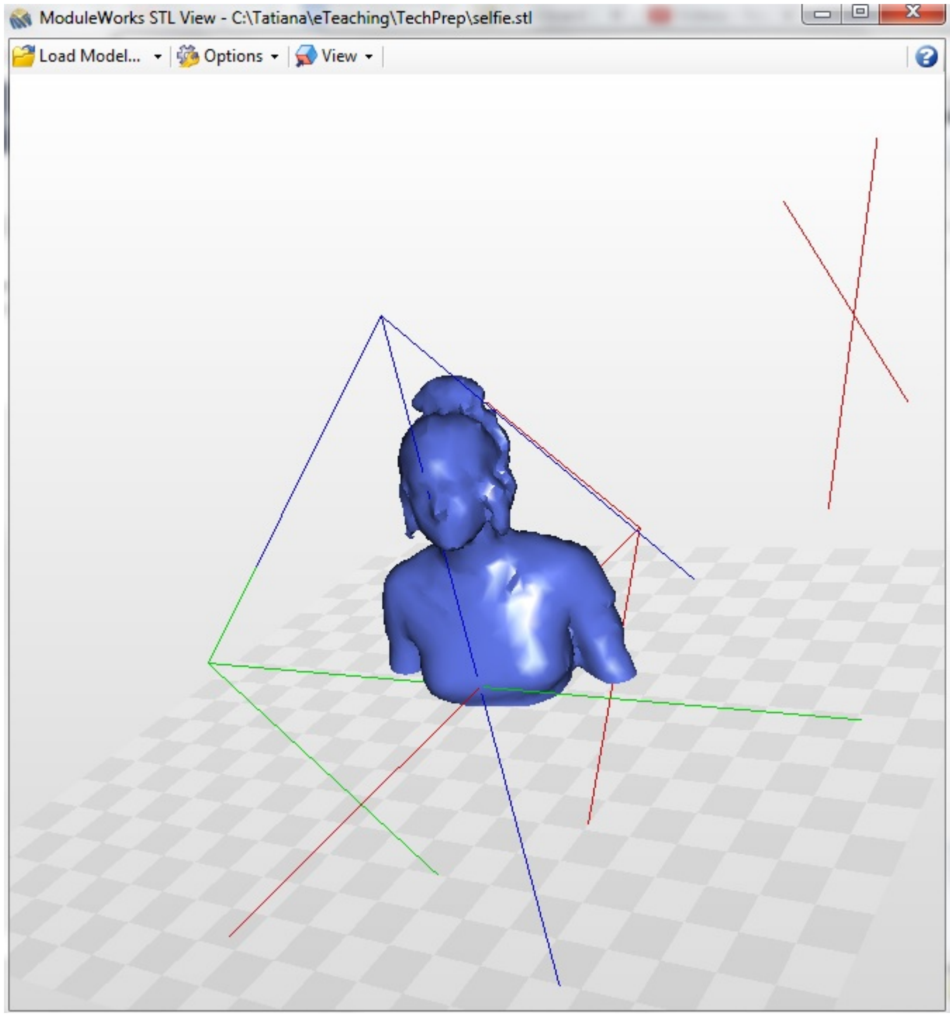

Figure 5a. Scanned 3D selfie

Figure 5b. 3D modeling

Figure 6a. 3D printing

Figure 6b. 3D printed selfies

Figure 7a. Occulus Rift

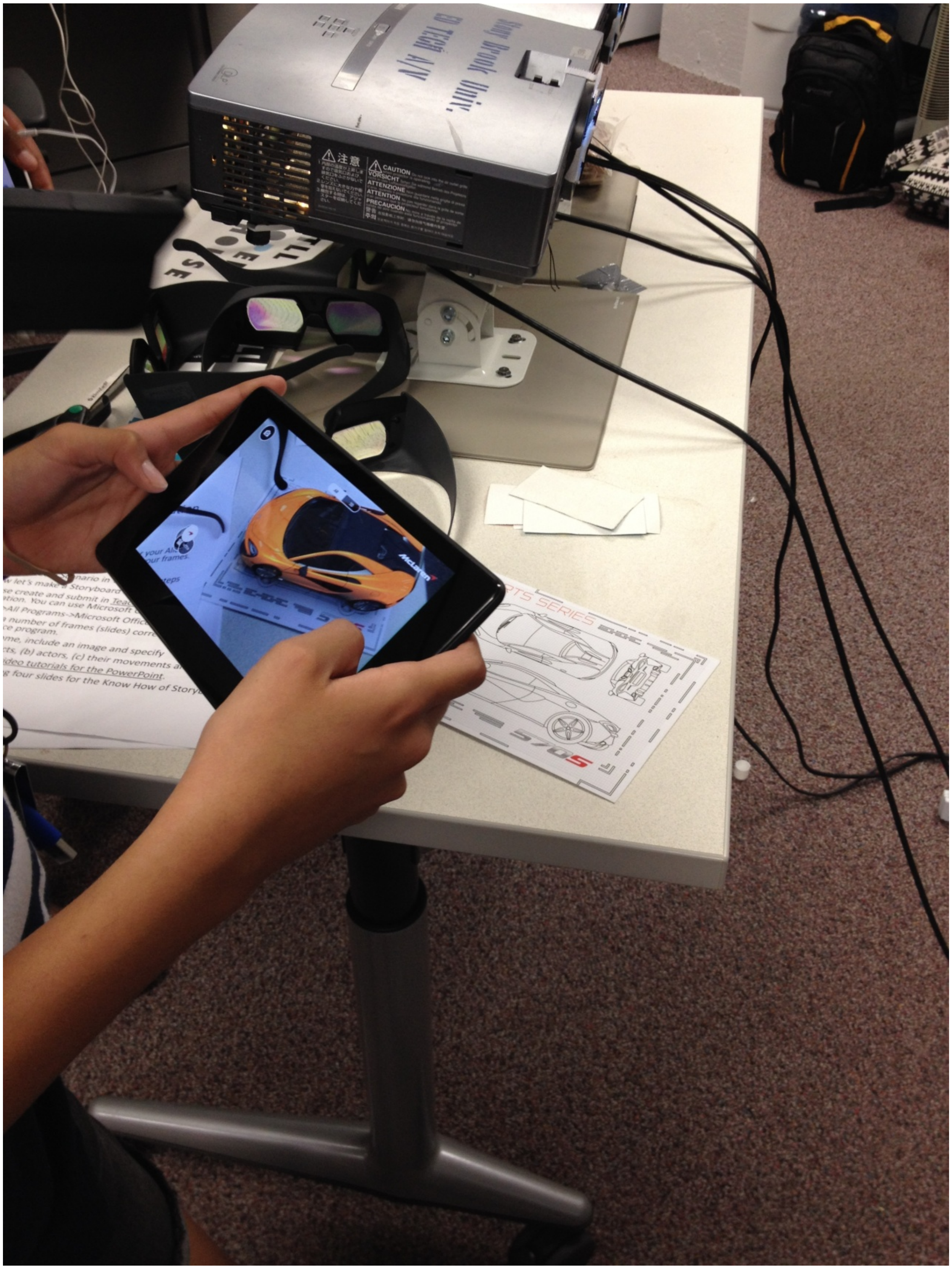

Figure 7b. Augmented Reality car


EXIT
INNOVATION LAB
Green Screen
No food is permitted in the facility.


INNOVATION LA
THINK. CREATE. INNOVATE.

Figures 7c, d. Green screen picture taking

Measures and Instruments

Digital literacy, digital competence, digital skills models were created in US as well as in European Union and other countries [26, 27]. Digital skills training was suggested by many [28, 29]. Digital Literacy Assessment Instruments proliferated.

For the digital fluency assessment, we have chosen a standardized software simulation online test, the NorthStar Digital Literacy Assessment tool, which was validated in 2010 [30]. See Digital fluency assessment rubrics in Appendix 3.

As an alternative, students took quizzes of Basic Computer Skills, WWW skills, Windows Basic skills, and Internet Security, scored from 100 percent. The results of Digital Fluency, obtained from two different methods of testing, correlated.

In the 1970th, cognitive psychologists developed spatial ability tests based on mental rotation of 3D objects [31]. Thus, spatial ability was measured via the standardized mental rotation test scored from 10. Mental rotation test online link and screen shot are given in Appendix 4.

Results

Correlation analysis performed with SPSS 23 software has demonstrated statistically significant association between spatial ability and digital fluency of the subjects, consistent with our results on a larger sample of 73 undergraduate students at Stony Brook University in 2014/15 [18].

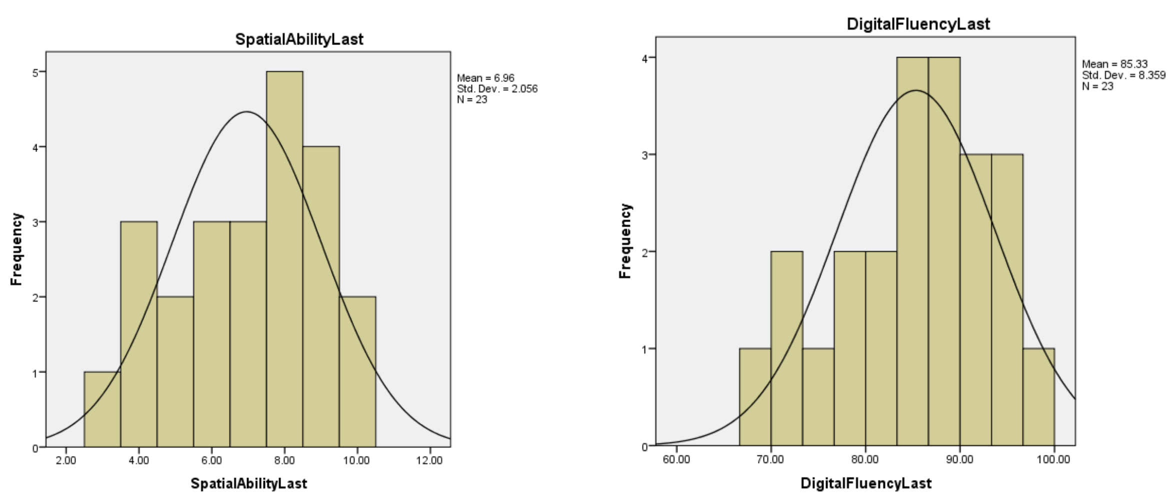

Figure 8. Histograms of Spatial Ability and Digital Fluency

Correlations

		DF1	SA1
Pearson Correlation	DF1	1.000	.567
	SA1	.567	1.000
Sig. (1-tailed)	DF1	.	.002
	SA1	.002	.
N	DF1	23	23
	SA1	23	23

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	496.136	1	496.136	9.961	.005[b]
	Residual	1045.937	21	49.807		
	Total	1542.073	22			

a. Dependent Variable: DF1

b. Predictors: (Constant), SA1

Table 4. Correlation of DF&SA, significant at .002, ANOVA ($F(21,1) = 9.96$, $p = .005$)

As a result of DigitPrep training, spatial ability of the students improved by 2 points from 10 in average, by one point in average after kinesthetic learning (3D media objects creating and producing), and by another one point after using surrogate embodiment (3D programming). Rise in spatial ability can be as well associated with the use of online materials uploaded to the Blackboard virtual environment [14].

Statistics

		SpatialAbilityInitial	SpatialAbilityLast
N	Valid	23	23
	Missing	0	0
Mean		5.0435	7.1304

Statistics

		DFInitial	DigitalFluencyLast
N	Valid	23	23
	Missing	0	0
Mean		78.8826	85.6130

Table 3. Means of the initial and final spatial ability and digital fluency results

Statistics

		DFInitial	DF2
N	Valid	23	23
	Missing	0	0
Mean		78.8826	82.6413

Statistics

		DF2	DigitalFluencyLast
N	Valid	23	23
	Missing	0	0
Mean		82.6413	85.6130

Table 4. Impact of traditional training on digital fluency (DF2) compared to the impact of surrogate embodiment (3D programming) and kinesthetic learning (3D objects producing)

Digital fluency score has risen by 7 points from 100 in average: 4 points after traditional learning, and 3 points after the 3D programming course. In spite of the fact that the impact of traditional 2D training on digital fluency seems to be numerically slightly more important than the result of 3D activities, we should say that both 2D and 3D activities were administered to the same group of subjects successively, so the final digital fluency data represent the cumulative effect of two types of training taken together.

Timed Blackboard treasure hunt results might have been confounded by the help that students were receiving from monitors and instructor. The help was not simultaneous, so the treasure hunt results, i.e. the Blackboard submission time for the Alice animations, was probably determined by the time when help was delivered.

Finally, the subjects having lower scores of spatial ability and digital fluency benefited more from the training than their classmates more fluent digitally and/or more spatially savvy. This result is consistent with previous studies [15, 16].

Conclusions

We created DigitPrep, a method based on 3D game programming and 3D printing, for training spatial ability and developing digital fluency, thus engaging interest and increasing access to STEM fields, preparing students to entering higher education, and succeeding in chosen careers.
The hypothesis that spatial ability can be improved using kinesthetic learning (3D media objects creating and producing) and surrogate embodiment (3D programming) has been confirmed. We were not able to confirm another hypothesis, that 3D activities were more effective for the digital fluency training than traditional 2D computer simulations/videos. However, cumulative effect of both types of training was superior to the separate effects of each of the training types. Therefore, we recommend the DigitPrep training introducing students to any program using online or computer-based learning materials.

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Appendix 1

Table 1. DigitPrep program schedule

DF traditional computer training

#	Content
1	DF test: Basic Computer Skills
	SA test: mental rotation (Shepard)
	BB treasure hunt
2	Computer basics (CB Quiz)
3	Windows Basics (WB Quiz)
4	Office Software (ex: MS Office 2013 PowerPoint, Google Docs)
5	WWW Basics (Connecting to the Internet, Browser basics, Search strategies, Web Quiz)
6	Email Basics or Gmail
	How to make a Screen Shot. Edit an image using Paint. Web file formats.
	How to create a YouTube account How to take, edit, upload, and download a video
7	Internet security, Social Media Etiquette Cyberbullying
8	DF test: Basic Computer Skills
	SA test: mental rotation (Shepard)
	BB treasure hunt

SA and DF training using 3D activities

#	Content
1	DF test: Basic Computer Skills
	SA test: mental rotation (Shepard)
	BB treasure hunt
2	Showcase of Augmented, Mixed, and Virtual reality (head mounted displays (ex. Oculus Rift), 3D cube, virtual planetarium, haptic devices), scanning and manipulating the visualization of 3D selfies (Skannect, Blender) at TLT Media lab
3	3D modelling and 3D printing, College of Business Innovation lab

4 Creating animation/game in Alice 3D programming environment

Day 1: Intro to programming, Alice Scenario, Storyboard, World, Editors

5 Creating animation/game in Alice 3D programming environment

Day 2: Working with the scene & code editor in Alice.

6 Creating animation/game in Alice 3D programming environment

Day 3: Methods, parameters, functions, conditional statements with Alice.

7 Creating animation/game in Alice 3D programming environment

Day 4: Events with Alice. Finishing the Alice project. Presentations.

8 DF test: Basic Computer Skills

SA test: mental rotation (Shepard)

BB treasure hunt

Appendix 2

Detailed Curriculum for TecPrep 2015

(with Alice lesson plans from Oracle Academy)

June 29 – Introductions, SA test, DF test,

Computer and media skills training:
How to take a screen capture

How to create a folder, How to save a file in a folder
How to send an email
Word Editor: Create a scenario for your game
Make Story board in ppt
How to create a YouTube account
How to record a video, How to upload a video
Internet security

June 30 – DF test,

Virtual and Mixed Reality,

demo of AutodeskViewer,

Excursion to the Media Lab

Showcase of 3D technologies

Scanning selfies

July 1 –

9 to 11 am Engineering computer classroom 105

11 am to 1 pm Innovation Lab,

Harriman Hall

Introduction to programming.

Getting started with Alice.

Comprehension test.

Innovation Lab Workshop

July 2 – SA test. Working with the scene & code editor in Alice.

Get Started with Alice 3

- Identify scene components
- Create and save a new project
- Add an object to a scene
- Communicate the value of saving multiple versions of a scene
- Code a simple programming instruction
- Use the copy and undo command
- Understand the value of testing and debugging

Add and Position Objects

- Open a saved version of a project
- Add multiple objects to a scene
- Describe the difference between precise positioning and drag-and-drop positioning
- Use a one-shot procedure to precisely position an object in a scene
- Edit properties of an object in the Scene editor
- Describe three-dimensional positioning axes
- Position the sub-parts of an object in the Scene editor

Second group: scanning 3D selfie in the Media Lab, First group: Printing selfie

July 6 – Scene setup with Alice.

Declare Procedures

- Compare and define an animation and a scenario
- Use functional decomposition to write a storyboard
- Flowchart a storyboard
- Describe inheritance and how traits are passed from superclasses to subclasses
- Describe when to implement procedural abstraction
- Demonstrate how to declare a procedure
- Identify and use procedural abstraction techniques to simplify animation development

Use Control Statements

- Define multiple control statements to control animation timing
- Create an animation that uses a control statement to control animation timing
- Recognize programming constructs to invoke simultaneous movement

Third group: scanning 3D selfie in the Media Lab, Second group: Printing selfie

July 7 - Events with Alice.

Use Functions

- Use functions to control movement based on a return value

Use the IF and WHILE Control Structures

- Use the IF control structure to effect execution of instructions
- Use the WHILE control structure to create a conditional loop for repetitive behavior

Use Expressions

- Create an expression to perform a math operation
- Interpret a math expression

Use Variables

- Understand variables and how they are used in programming

Fourth group: scanning selfie in the Media Lab, Third group: printing selfie

July 8 – Effects and sound with Alice.

Use Keyboard Controls

- Use keyboard controls to manipulate an animation

Develop a Complete Animation

- Use functional decomposition to write a scenario and storyboard
- Complete an animation
- Test an animation
- Reposition objects at runtime
- Plan a presentation of a completed animation project

Record and save the animation video

Fifth group: scanning selfie in the Media Lab, Fourth group: printing selfie

July 9 - Finishing the Alice project.

Animation Design Worksheet

- Use an animation design worksheet to complete an animation

SA test, DF test, Demonstrations. Innovation Lab Workshop #2,

Fourth group, then fifth group: printing selfie

Appendix 3 Digital fluency assessment rubrics

The Digital Skills Standards

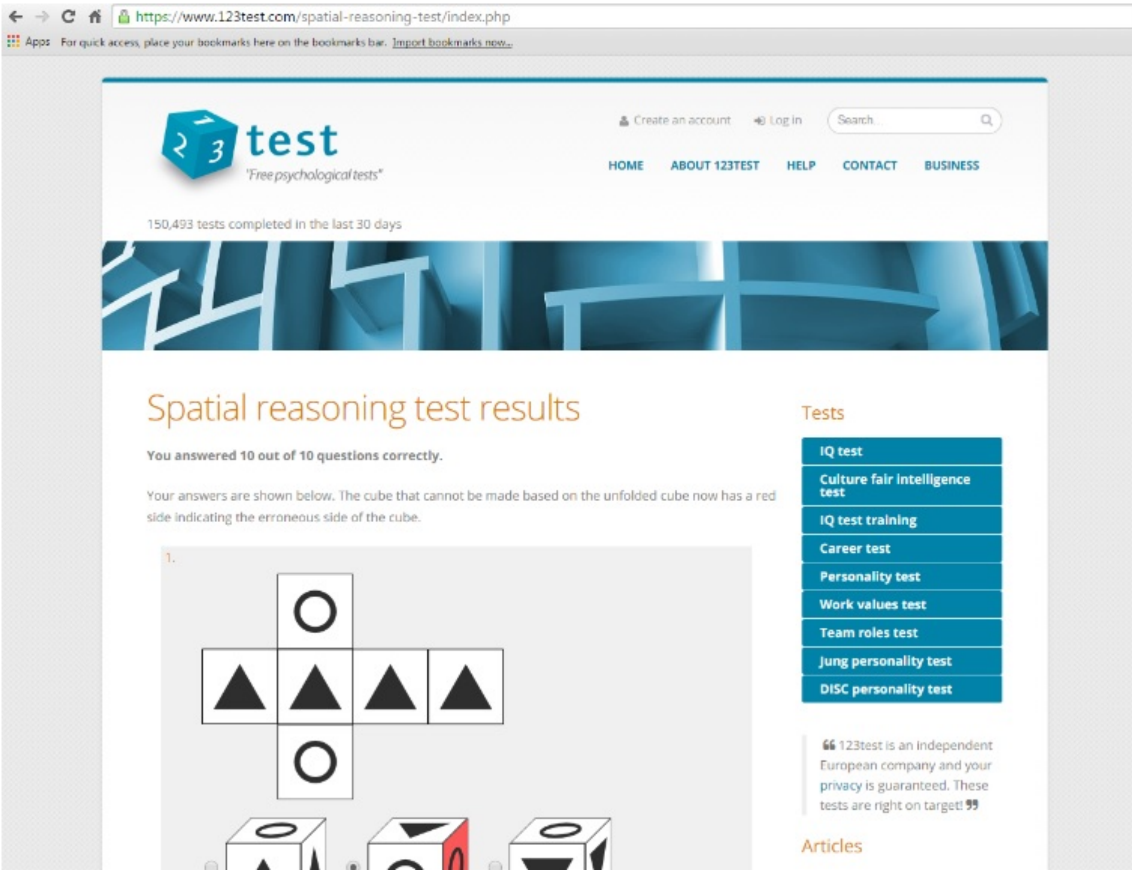
Retrieved from Inernet on 02/02/14 at Northstar Certificate

Basic Computer Skills

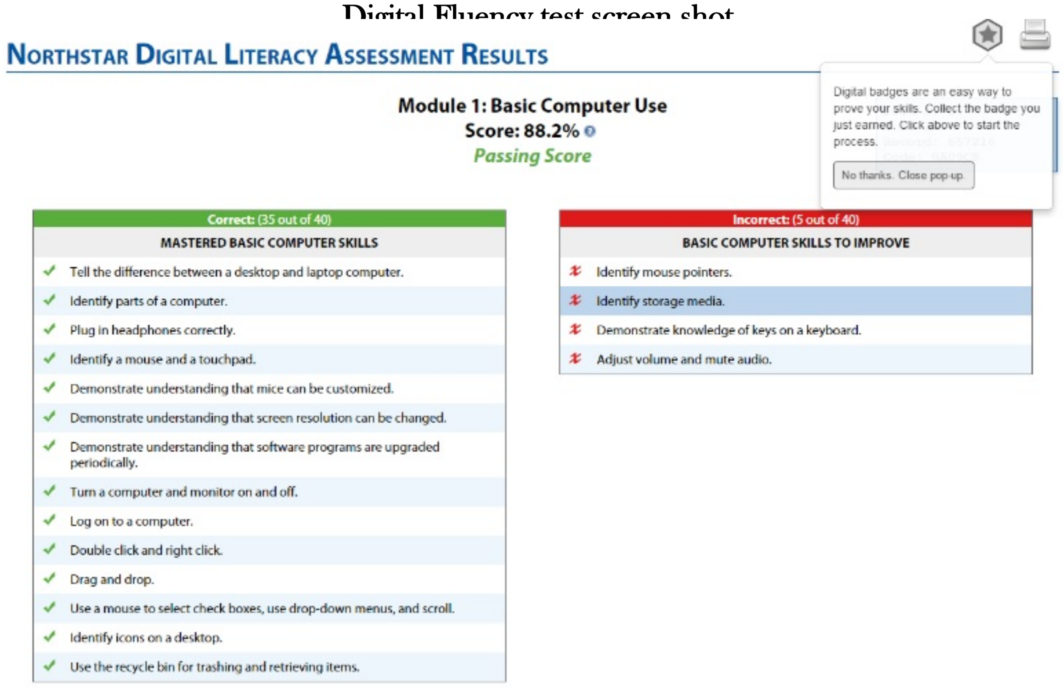
1. Distinguish between desktop and laptop computers.
2. Identify specific computer hardware: a system unit, monitor, printer, keyboard, mouse or touchpad, USB port
3. Turn computer and monitor on and off
4. Log on to computer
5. Demonstrate knowledge of function and placement of keys on keyboard: Enter, Shift, Control, Backspace, Delete, Arrow Keys, Tab, Caps Lock, Number Lock
6. Identify types of mice: mouse and touchpad
7. Identify mouse pointer shapes and match them to the correct context of use: typing arrow (text), arrow (basic clicking), hand pointer (clickable links)
8. Demonstrate appropriate use and ability to right-click and left-click
9. Double click and right click
10. Drag and drop
11. Use mouse to select check boxes, use drop-down menus and scroll
12. Adjust volume and mute audio
13. Plug in headphones correctly and use when appropriate
14. Identify icons on desktop (Internet Browser, Control Panel, Recycle Bin, Skype)

15. Demonstrate the ability to use the recycle bin correctly for trashing and retrieving items
16. Demonstrate understanding that it is possible to customize a computer for increased accessibility
17. Demonstrate understanding that mice can be customized for left-handed people and that the speed of clicking can also be customized
18. Demonstrate understanding that screen resolution can be changed
19. Demonstrate understanding that software programs are upgraded periodically and that different versions may be installed on different computers
20. Identify storage media: USB/Flash drives (external) and hard drive (external and internal)

Appendix 4 Mental rotation test screen shot



Digital Fluency test screen shot


NORTHSTAR DIGITAL LITERACY ASSESSMENT RESULTS

Module 1: Basic Computer Use
Score: 88.2%
Passing Score

Digital badges are an easy way to prove your skills. Collect the badge you just earned. Click above to start the process.
No thanks. Close pop-up

Correct: (35 out of 40) MASTERED BASIC COMPUTER SKILLS
✓ Tell the difference between a desktop and laptop computer.
✓ Identify parts of a computer.
✓ Plug in headphones correctly.
✓ Identify a mouse and a touchpad.
✓ Demonstrate understanding that mice can be customized.
✓ Demonstrate understanding that screen resolution can be changed.
✓ Demonstrate understanding that software programs are upgraded periodically.
✓ Turn a computer and monitor on and off.
✓ Log on to a computer.
✓ Double click and right click.
✓ Drag and drop.
✓ Use a mouse to select check boxes, use drop-down menus, and scroll.
✓ Identify icons on a desktop.
✓ Use the recycle bin for trashing and retrieving items.

Incorrect: (5 out of 40) BASIC COMPUTER SKILLS TO IMPROVE
✗ Identify mouse pointers.
✗ Identify storage media.
✗ Demonstrate knowledge of keys on a keyboard.
✗ Adjust volume and mute audio.

Appendix 5 Software and hardware used for the training program

Alice 3.2.5.0 by Carnegie Mellon University

Blackboard Course Sites MOOC platform
Skanect 3D Scanning Software By Occipital
Blender 3D modelling by Blender foundation
Smart Technologies computer classroom kit
TinkerCad 3D design tool
Green Screen app by Do Ink
Aurasma Studio mobile app

Kinect sensor by Microsoft
Oculus Rift by Facebook
Home-made Augmented Reality Cube by SBU Media Lab
Head-mounted displays
Color 3D printer

Supplementary Materials:

Media 1. Video of Alice 3D scene with event triggered movements

Media 2. Online showview of the 3D scanned selfie

Display Items:

Item 1. 3D objects

Item 2. Smartphone animation

Materials and Methods

Appendix 3 Digital fluency assessment rubrics

Appendix 4 Mental rotation test online link and screen shot

Appendix 5 Software and hardware used for the training program

10.

Evaluation of Learning Techniques in Immersive Settings

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Abstract: Our research has shown that learning in a planetarium dome can be measured quantitatively and is proven to result in greater content retention than watching the same experience, but in flatscreen mode on a computer screen. Concept acquisition in the planetarium is measured in several pre-post assessment studies annually at the Houston Museum of Natural Science's planetarium with random sampling of fourth grade students from over 15,000 attending from the Houston Independent School District each year. The results of these on-going required and rigorous evaluations are summarized, focusing on successful practices in planetarium teaching and concepts most effectively learned. In a second study, two hundred middle school students were pretested, then shown the same experience on either a computer screen or in a Discovery Dome portable planetarium. When tested immediately after viewing, both groups showed significant content gains. However, when retested six weeks later, the group who watched on a computer screen had lost most of their gains, whereas the group, which had watched in a dome, lost none of their gains. We suggest that the immersive environment provides a more active learning experience that leads to longer lasting learning.

One Sentence Summary: Learning in an immersive environment can be measured and leads to greater content retention than learning in a flatscreen modality.

Main Text:

Introduction:

Engaging youth in learning activities is increasingly competing with social media, games and other technologies. Of the "Five E's" of education (Engage, Explore, Explain, Elaborate, Evaluate) [1], a planetarium dome really shines in "Engaging" student interest. Over the past 17 years, the authors have collaborated on producing more than 30 fulldome planetarium shows, 23 of which are still in distribution [2]. Many of these shows were created under NASA Cooperative Agreements, which require evaluation of effectiveness. The retention study cited here is one of these evaluations.

The Houston Museum of Natural Science and the Houston Independent School District (7th largest in the US) have a 50 year old partnership in which teachers from HISD teach HISD students in the Museum's Burke Baker Planetarium and must present a program that strictly adheres to HISD grade specific science proficiencies and is evaluated quantitatively to measure student concept gains annually. Concept acquisition results presented herein are a result of this rigorous required evaluation program that has provided a planetarium learning experience for over a million inner city students.

Scope of Work:

This study builds on prior evaluation studies and extends to additional research in effectiveness of learning in an immersive setting.

Research Findings:

The Retention Study

Research Protocol. In order to assess whether learning in a dome is more effective than learning from the same show in a flatscreen format, our evaluators performed a study [5] using the show "We Choose Space!" [6]. They took the portable Discovery Dome to an inner-city middle school with a predominantly underserved student population. The evaluators separated the 200 students into two equivalent groups, and gave each group a pre-test to evaluate prior knowledge. Then one group saw the planetarium show "We Choose Space" in the portable dome, and the second group watched the DVD version on computer monitors. The sound track and script for both versions were identical. The imagery on the computer version was cropped, unlike the version in the dome, which surrounded the students, but still included all tested concepts.

Results. After watching the show one time, both groups were administered a post-test with identical content questions, plus some attitudinal questions. To see the actual questions, refer to the published study [5]. Both groups showed significant content gains (Table 1). The dome viewers showed a slightly larger gain (9.8%) than the computer viewers (8.9%), but this difference was not statistically significant.

Middle School Students, Houston, Texas, Paired Samples T-Test by Delivery System

Delivery Mechanism	Number	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Gain	Paired Diff SD	*t-value*	*p-value*
Computer	107	53.67	19.37	62.55	21.45	8.88	21.45	4.63	<0.0005
Dome	93	50.54	20.33	60.29	20.52	9.75	17.10	5.50	<0.0005
Total	200	52.21	19.46	61.50	21.00	9.29	18.58	7.069	<0.0005

Table 1. Pre- and post-test scores by delivery mechanism, given as percentage of questions answered correctly. The computer users showed a 8.9% gain whereas the dome viewers showed a 9.8% gain, both significant at the .0005 level.

Retention. To determine which group achieved better retention of the material, both groups were administered the same post-test six weeks later. The answers of each student were matched with their prior pre-test. Roughly half of the students were not in attendance the time of the final pretest, so the pretest averages and number of participants changed somewhat. In this comparison, the dome viewers had a content gain (10.5%) which was actually slightly larger than immediately after the viewing of the show. On the other hand, the gain of the computer viewers had fallen by 2/3, to only 3.5% increase over their pre-test, and even that gain was not statistically significant (Table 2). Essentially, the dome viewers had lost none of their gains, but the computer viewers had lost essentially all of their gains.

Sample of Middle School Students, Houston, Texas, Paired Samples T-Test, Long Term Retention

Delivery Mechanism	Number	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Gain	Paired Diff. SD	*t-value*	*p-value*
Computer	47	60.49	60.49	63.98	23.31	3.49	27.78	0.863	.393
Dome	58	50.12	15.57	60.59	17.15	10.47	17.30	4.608	<0.0005
Total	105	54.76	19.28	62.11	20.11	7.34	22.75	3.309	.001

Table 2. Pre-test and long-term retention post-test scores by delivery mechanism, given as percentage of questions answered correctly. The computer users gain fell to 3.5% (not statistically significant) whereas the dome viewers rose to 10.5% gain, significant at the .0005 level.

Attitudinal Changes. The post-test also measured the student's attitudes about space, and, even after one show, their responses clearly indicated their increased interest in learning about space and space travel (Table 3).

Attitudinal Changes After Viewing *We Choose Space*…

	N	Yes	No	Maybe
Do you want to know more about space travel?	190	46.3	13.7	40.0
Did you want to know more about how to live in space?	190	64.7	16.8	18.4
Did you wonder what it would be like to live on the moon?	186	69.4	13.4	17.2
Would you want to be a space traveler?	185	33.5	31.9	34.6
Did you wonder what it would be like to live on the space station?	186	60.2	20.4	19.4
Did you wonder what it would be like to live under a dome?	189	51.3	26.5	22.2

Table 3. Survey of student attitudes after watching the show "We Choose Space" (both groups combined).

Evaluation of Concept Learning in a Planetarium

Over the last 50 years, evaluation requirements and techniques have changed dramatically in the HMNS-HISD planetarium experience. With more state and local standardized testing, the planetarium has become more responsive to specific concepts and their applications for the 4^{th} grade student. Pre-Post assessments have become multiple choice instruments administered in a variety of ways from pre-post testing students with several weeks separating the planetarium from the testing, to pre and post assessments done during the students' half day museum visit. Evaluation protocols have measured learning gains in the individual student, as a class of students, or in equivalent groups of students. Significance is measured by performance on the whole evaluation instrument as described below and also by item since the study's interest is in specifically what is being learned and how learning can be improved on specific concepts. Figure 1 shows the distribution of student scores in one study of 438 fourth grade HISD students who were pre and post tested in their classrooms. The t-test for paired yielded a t (19.39) that was statistically significant ($p<.001$). In addition, the analysis yielded an effect size (+1.27) that suggests that the gains made by the students from the pretest to the posttest were both statistically significant and educationally meaningful. In addition, the results indicate that the number of correct responses for the twenty-two items on the posttest was greater than the number of correct responses for all but two of the twenty-two items on the pretest. The randomly chosen 8 schools that participated in this study have populations that are 85% on free lunch and 99% underrepresented minorities.

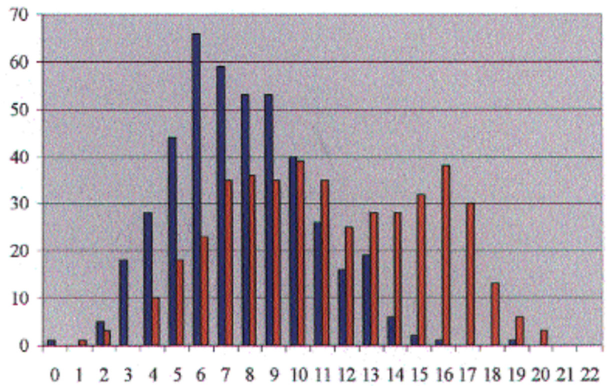

Figure 1. Histogram of pretest scores plotted in blue (number of items correctly answered) and posttest scores plotted in red for 22-item multiple choice instrument given to 4th grade students.

Several hundred students are assessed each year with results similar to those above. Over the years, patterns in student performance on individual items have developed. The planetarium is most effective in promoting student learning when:

1. Baseline student knowledge is low and may even indicate a level of misinformation
2. Concept acquisition requires a change in reference frame for the learner. The planetarium can reduce the complexity of a concept like diurnal rotation, for instance, by giving students direct experiences with the motion from the space reference frame and from the observer on the Earth's surface in juxtaposition.
3. Content is presented in an engaging, exciting, and dramatic manner in the planetarium experience, rather than just stated by the planetarium teacher.
4. Content is presented in a long sequence (over 30 seconds) and/or more than once in the planetarium experience.
5. Concepts are presented in 3D immersive scenes with the concepts are in action.
6. The learner is encouraged to interact with the planetarium teacher.

Assessment items are modified whenever mandated proficiencies change or new planetarium learning experiences are created to address items where learning gains are not highly significant. This on-going iterative process has identified the following conditions in the planetarium that increase the probability of student concept acquisition.

1. Watch the planetarium experience rather than just read the script. Learning is more correlated with what students see than with what they just hear. The visual nature of the immersive planetarium experience is a great strength in promoting learning.
2. Consider the role of the live planetarium operator interacting with students, asking and responding to student questions. This is needed in presenting complex concepts.

3. Recognize that prior knowledge can interfere with presenting a complex concept. The planetarium is a very effective environment for addressing misconceptions that can play a negative role in student mastery of a concept.

4. The most difficult concept to teach in a planetarium or in a classroom is one that requires students to change reference frames. Our 2015 study indicates that we are making progress in this area and that the key is to keep students in the space reference frame, which the planetarium provides.

Each year specific research findings and item analyses are provided to the Houston Independent School District by the Houston Museum of Natural Science as a requirement for continued funding of the field experience. Specific examples can be provided to illustrate all of the points made in the summary provided above.

Long-term Impact on Teachers and General Public

In a paper about the "Education and Communication for the Magnetospheric Multiscale Mission" [7], we surveyed teachers, museum educators, users of NASA software and a control group from the general public on the influence of planetariums and NASA outreach on their interest on science and on their careers. Over half of the respondents selected planetariums as an important way they received information on NASA during their school years, and a third selected it as an important way to receive NASA data now (the highest ranked mechanism now is the web). When asked "should NASA continue to fund development of educational materials and planetarium shows, over 90% replied "Absolutely" or "Yes". Clearly planetarium programs should continue to be important educational mechanisms into the future (Fig. 2).

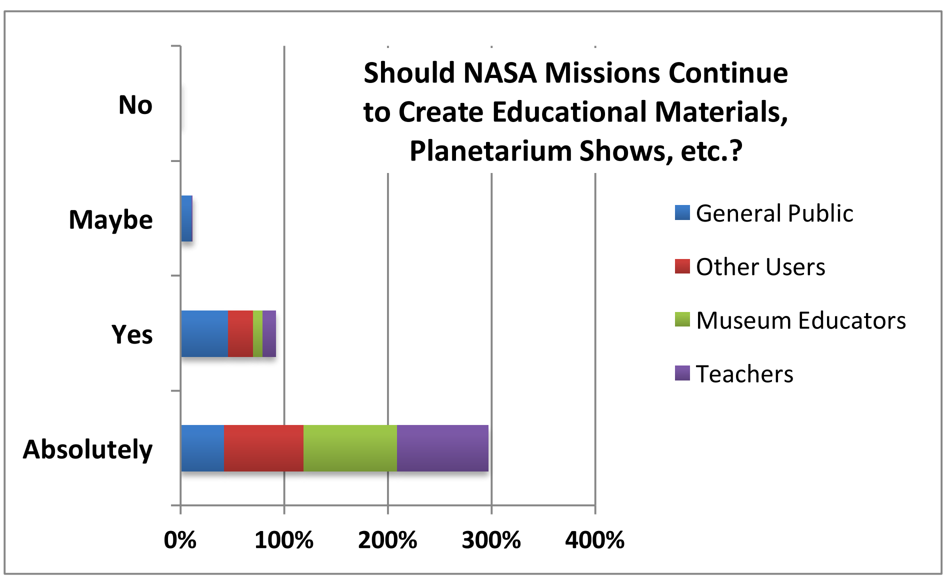

Figure 2. Histogram of responses of four groups surveyed: teacher users of NASA product (purple); museum and planetarium educators (green); other users (red); and a control group of random adult internet users (blue). All agree NASA should continue to

create educational materials and planetarium shows (From [7]).

Conclusions

The planetarium is an effective learning environment. Its immersive nature fosters student engagement, creates more lasting student memories, and uniquely addresses how students learn complex astronomy concepts. It enhances positive student attitudes about learning about space. Finally, a poll of teachers and general public users shows overwhelming

References and Notes:

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11.

Impact of Immersive Education on Workforce Behavior

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Affiliations:

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[2]Two of the authors also have an affiliation with the University of Southern California; www.usc.edu .

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Abstract: Over 60% of the workforce in the United States alone are hourly wage workers whom lack the basic skills needed to succeed in their careers. These students generally did not succeed in didactic, formal learning settings. For these underserved populations training is their last hope of remediation and a productive economic life, but new pedagogies that will best engage them must be applied. We have begun to apply immersive education and are garnering some success based on multiple measures. We believe that education must become immersive (Oculus Rift, interactive video, gaming) and driven by Big Data that responds to their needs (IBM Watson and facial recognition software). We are harnessing technology to close the skills gap. This paper discusses a work-based immersive learning intervention. It presents the approach, discusses the employer goals and then provides some preliminary findings and discusses the potential implications of the initial findings.

One Sentence Summary: Initial evidence suggests that well designed immersive learning contextualize for work can significantly improve employee performance.

Main Text:

Introduction

This paper outlines Cognotion's Approach to the application of immersive learning in the context of learning at and for the world of work. As Cognotion is a commercial company, the methodological component in this piece is by design different than a researcher testing the efficacy of a pedagogical tool within the context of a formal education setting. The "customer" is not the learner, and the relationship between the customer and the provider is primarily a commercial one. Consequently, the primary purpose of this paper it to present a hypothesis and then introduce a case and some anecdotal evidence to catalyze a conversation and suggest further research on the issue of immersive learning for the world of work.

We raise this issue because it is not trivial in terms of the designing of the solution, its delivery, and the evaluation of its efficacy. We do believe, however, that commercial providers can and should contribute to conversations of efficacy but wanted to situate this paper in the appropriate frame so that the reader can evaluate it appropriately.

The paper will first present the overarching challenge Cognotion addresses and its theory of change and how that manifests itself in terms of the pedagogical tools brought to bear in its education offerings. The paper then will present the specific intervention associated with the empirical evidence gathered as well as the methodological approach used to inform the results, then present the results and discuss them.

Problem Statement

The ability of adults to find meaningful work and to perform the tasks requisite with meaningful work is one of the world's largest problems. We are all quite familiar with the bleak data on youth unemployment in parts of the EU and in the United States, the picture is no less bleak. From the employers' perspective, recent studies all talk about a "skills gap" [1,2,3]. Specifically, that the vast majority of employers cannot find the talent they need to do the work they need done.

From a public policy perspective, this has enormous consequences. It impacts the tax base both of companies and of employees, and creates a human capital gap cascade, with adverse impacts on everything from crime rates to health indices.

Therefore, targeting work as the place to provide employees with learning that will improve their ability to retain jobs and to get promoted is prudent and it is in line with employers needs and as a consequence, according to sources such as the US Chamber, employers spend hundreds of billions of dollars for the design and delivery of work related training interventions [4,5].

What is striking to us is given the scope and scale of the problem to employers and to society and the amount of money spent, there is little evidence of efficacy and at least anecdotally, the completion rates are quite low and the efficacy not apparent.

Our hypothesis is that this is a function of several things. First, is a failure to not sufficiently diagnose the root cause of the performance gap. Then, to not source adequate content and perhaps most relevant for our purposes, to not design learning to meet the needs of learners.

For us it should be self-evident that if a learner has historically not performed well in traditional, didactic classroom setting, that replicated that pedagogy for work will lead to similar failures. We hypothesize that using techniques developed in the world of Hollywood film-making and gaming, combined with good learning science is much more likely to engage the learner and make her understand the import and teleology of the intervention, which will lead to higher completion rates and better job performance.

Approach to Learning

Modeling ourselves after social scientists, we believe that any successful intervention has three components – diagnosis, prescribing the right intervention and then delivering that intervention effectively.

Our Diagnostic Approach – The Business Performance Challenge

In our view, most course offerings in corporate learning are divorced both from the context of work and the performance problems employees face. To address this issue and to increase likelihood of efficacy, we use an ethnographic business performance challenge methodology that allows us to observe and interview and gather ancillary evidence to help conduct a root cause analysis of the performance problem.

To ensure a course is capable of significant business impact and high learner engagement, you must understand the business challenge(s) that that the organization faces as well as the new capabilities that must be developed to address it.

The process is fairly straightforward, we need to understand the strategic goal, understand what people currently know and do, and then understand what they need to know and be able to do to meet the goal. This will be familiar ground to researchers fluent in needs assessment analysis [6,7].

By understanding the business challenge, we can better understand what new mindsets and traits learners need to exhibit, and why. The approach also helps with the engagement issue as learners are more motivated to acquire new skills if they see a direct connection between their development experience and a set of real challenges the organization is facing With an urgent/tangible business challenge, learners can work on a project that creates genuine impact for the organization. Understanding the business challenge allows learners to define success in terms of both learning *and* business objectives

We work with the client to define the business challenge the intervention would address, to identify measures that illustrate the degree of impact the program has on the business challenge. Impact assessments measure how the program is changing behaviors and contributing to improved performance outcomes of executives and emerging leaders. These measures are linked in a strategy map derived from the Balanced Scorecard philosophy to illustrate the required knowledge and skill that will build new behaviors and organization capabilities to deliver the desired performance outcomes needed to achieve the desired business results [8,9].

Learning Outcomes – We tailor the learning outcomes to the company environment. While learners must understand basic principles in the topics offered in the intervention, they must also be able to discuss these principles in the context of their company and industry.

These unique aspects of the intervention contribute to building a critical mass of new behaviors that become the foundation for new or improved organization capabilities.

Once we understand the business challenge thoroughly, we can match relevant course content to the business situation and tailor the experience to boost engagement and impact.

Our Curriculum Architecture

We think of our architecture as a set of tools available to us to do what is akin to “tailored” therapeutics. By correctly diagnosing a problem and then using great content for parts of the solution but tailored to the specific needs of the company and the job function and performance gaps, we provide the best of both worlds – top “off the shelf” with all the cost savings and substantive vetting and “custom” with all the nuance and context specific.

To build out our architecture, we use the framework developed by our partner, the Center for Curriculum Redesign. It has four major components: knowledge, skills, character, and metacognition [10].

Our Immersive Learning Approach

Our curriculum architecture gives us vetted and trusted content, but content needs to be transformed into effective learning that can be delivered at scale in the context of work to workers or aspiring workers who historically have underperformed academically. We therefore recognize that using a didactic approach is at best derivative and more probably totally pointless; it generally won’t work, regardless of the quality of the content.

Currently, Cognotion operates on the premise that there is narrative inherent in any teachable subject. We locate this narrative and craft it into an immersive storyline. The player progresses through the story by drawing upon existing resources and synthesizing new knowledge. Emotional proximity is characterized as the "empathy and identification the player feels for the characters in a game" and is established by developing characters with strengths and weaknesses, who change and grow as the game moves forward. Learners recognize their own desires and concerns in the prototypical heroes, people with traits similar to their own, who learn to draw upon their own reserves of strengths (assets) for the greater good [11,12,13,14,15].

This approach differentiates us, is grounded in research, and is a good foundation for a sound program; but there are other tools we add to our pedagogical design to maximize likelihood of impact.

Grounded in sound learning science. All of our materials align with learning science in terms of chunking and linking, context setting, and scope and sequence based on desired outcomes. We certainly use Bloom's Taxonomy, which works for knowledge and metacognition, but we build on that to also address skills and character facets of our curriculum since Bloom's is designed for knowledge in an academic setting [16]. We are honing our own methodology so that we can consistently deliver a scalable product that can be replicated from a quality assurance perspective. We are not a custom shop reliant on the magic of creative geniuses but are more akin to a combination of McKenzie Consulting combined with Pixar.

Problem-based/Project-based learning. Evidence is fairly convincing that both from an empathy perspective and in terms of synthesis, problem-based learning can be powerful. It also aligns well to a narrative approach to learning. The learning stories we build center around a problem of practice [17,18].

Multi-modal Learning. The research is pretty clear that learning styles is hogwash but there is also evidence that presenting information in various formats (sound, text, image, graph, etc.) can heighten understanding. We therefore use multiple modalities to present key concepts [19,20].

Practice/Experiential. We call our ultimate goal a cognotization, which is perhaps most akin to the notion of a healer's pedagogy which is *see it, do it, teach it.* Story is a very powerful way of getting folks to "see" and understand we supplement that with practice whether exercises or games/simulation. We are building out lab/experiential components in all of our offerings whether it is practice exercises or a simulation. This will evolve into a feedback rich environment [21].

Role of Teacher/Expert. We do know that students can learn without a teacher and that good teachers can help and bad teachers can hurt. We build our programs in such a way where they can be deployed in support of faculty or subject matter experts (always the “preferred” medium but oftentimes logistically or financially not viable). As a consequence we do design our programs to also function stand alone and are exploring the intriguing idea of using AI in the form of our partnership with Watson as virtual teaching assistants [22].

Role of Peers. We recognize the power of the peer effect, social learning, and communities of practice. Whenever possible, we prefer solutions that have these facets of pedagogy present; they enhance efficacy but again our interventions can function in the absence of peer to peer learning; they are simply better when those are present but designing that component as part of the solution is key; doing an ad hoc community of practice may detract from the efficacy of the intervention. Part of our solution can include the explicit design for this component [23].

Role of data & assessments. As a company we are empirical and we work with clients to build into solutions reasonable but reliable forms of evidence of efficacy. We aspire to use “big data” to do reliable and rich formative assessments. Our goal is to use learning AS assessment (this is the *Enders Game* metaphor where the lines being doing, learning, and testing are blurred). This becomes particularly compelling when one things about use of big data and adaptive learning and assessment and use of multiple forms of data such as facial recognition software.

Any web-based learning initiative, especially one that is almost exclusively self-directed, needs to address the challenge of attrition. This will be especially important for a program such as this where students may often participate in the learning experience without peer or instructor reinforcement outside of the game itself. Past studies on attrition in distance learning indicate that lack of time and motivation are major contributing factors. While instructional design cannot address the former, good design can in fact influence student motivation and therefore retention in distance learning programs. Further research indicates that motivation is a function of complex factors that include fantasy (motivating the imagination), curiosity (the promise of learning something about the world) and challenge (a goal that stimulates exploration and encourages new behaviors). Additionally, motivation is strengthened when the student begins a course with confidence that he can ultimately complete it. All of these factors are present in our design and methodology.

In terms of effective delivery, Cognotion is grounded in a quality assurance process specifically developed for the corporate learning/workforce market. Cognotion’s Chief Learning Officer chaired the ISO Technical Committee charged with developing standards for learning for and in the workforce, which was passed by ISO in 2012 and a subsequent one focused on foreign language training [24,25].

Outline of Intervention

A high-end luxury resorts company to solve a performance gap approached Cognotion. The company wanted to collect more email addresses and zip codes of its customers. This is because resellers such as Expedia were costing the company some 30% of its revenue. It believed that if it had email addresses it could market directly to its customer, offering discounts while concurrently capturing more revenue.

To meet this business goal, the company had tried both incentives (e.g., paying employees for each email collected) and had also tried to use it as a performance tool (e.g., “we will penalize you for failure to collect emails). Neither approach had any impact in terms of the collection of either emails or zip codes.

The prototypical employee has a high school diploma and is earning minimum wage.

The company has twenty-three properties in the United States. Cognotion proposed developing a pilot set of short immersive interventions to be delivered at three properties to explore the efficacy of the approach to solving the problem.

The company’s goal was simple. To increase the number of emails and zip codes collected upon guest registration.

Cognotion conducted ethnographic work, both interviewing and observing front desk employees on the job. With that data, Cognotion designed a simple story-based immersive interaction video series of vignettes designed to make the employee the hero; either helping a little girl get her teddy bear back or an executive reunite with their lost computer.

The intervention was delivered on mobile devices and consisted of six discrete but interrelated modules; none of which was longer than 7 minutes.

The total number of front desk employees was 68, 59 of whom (87%) enrolled in the course. The number of employees who completed the course was 46 (78%). The average percent of course completed was 83%.

The three sites saw a 69% increase in the number of zip codes collected in the 30 days after the completion of the training. With respect to emails collected, the increase was 44%.

Discussion of Initial Results

The initial results of the small pilot are promising. Indeed, from a commercial perspective, where the bar is to simply please the customer, the intervention vastly exceeded the customer's expectations and they have asked to scale the initiative.

The small sample size makes it hard to make any sort of true inference [26]. We also suspect that there is some sort of site effect as there was variance among the sites in terms of both participation rates and completion rates that may be correlated with outcomes (the sample sizes are too small to analyze the sites separately but the largest site also had the largest engagement rate and the lowest percent change perhaps suggesting some sort of selection bias (i.e., if everyone does it the impact is different than if only more motivated employees complete the training) in addition to a site bias.

We also don't know yet the "stickiness" of the intervention. We have designed some follow up "refresher" modules but long-term effects are unknown.

There also could be a simple placebo effect since the employees – many of whom told us they receive little training – seemed to greatly appreciate that the company was spending money on training for them.

Next steps would be to design a much larger and more reliable evaluation of an intervention that would allow us to both randomly assign sites and employees within sites and to better control for variance in the intervention.

That said, this small intervention suggests that well designed immersive learning delivered in the context of work, which allows the learner to both, understand the issue/goal and to make the correct decision when it comes to the performance goal.

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12.

Live conformal scaling of full-body immersion environments in the case of augmented reality systems and internet of things.

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Abstract: Virtual and augmented reality systems, robotics stuff are the novel technologies of today. They let artists and teachers to develop real-time performances and immersive lessons by themselves. Thus, end-users and non-programmers get the full-featured connected virtual-real space to manipulate. They can use these technologies just anywhere in a school, theatre, art gallery or learning lab. However, the scaling of the created full-body immersion environments is still a complex task and is connected with the process of live programming. Actually, an existing software for building immersive environments are the huge set of the extensions and tools. On the contrary, the virtual worlds provide all-in-one solution and the ability for the programming code to be delivered in a lightweight manner through the network. The virtual worlds support easy synchronization for many users to interact with common objects and environments. These objects can be programmed on quite different languages. In addition, they can coexist alongside with each other in the same replicated virtual world and holding the same simulation. That allows scaling a full-body immersion environment in mixed scenarios alongside with augmented reality systems, cave automatic virtual environments and internet of things. The paper describes the prototypes of such full-body immersion environment, which is developing using the open source project Krestianstvo software development kit. The source code for the prototypes is available on http://www.krestianstvo.org

One Sentence Summary: The paper discusses a full-body immersion environment that is run by virtual worlds and could be scaled up to any number of nodes, being programmed with user-defined languages in real-time.

Main Text:

Introduction

Full-body immersion environments are complex systems and consist from many hardware and software components. Mostly only experts can supply and support such environments. Sometimes there is no any possibility for reconfiguration or adaptation of them by a people from other disciplines, like teachers and artists. In other words, such systems provide a static hardware and software templates for filling them up with the educational or artistic content. That forces an end-user to create educational scenarios in the form of dynamic data using a static computational paradigm. Finally, these systems are used like static viewers with rich human-computer interactive interfaces. Things would change if we look at the full-body immersion environments as an augmentation of the virtual worlds and the computation-centric live programming environments. The virtual worlds represent the new computational paradigm and the new form of software, where everything is just some form of a computation. End-user could generate or change the content of a virtual world in real-time. The user also is represented in a virtual world as a computational process, an object known as avatar/software agent. Moreover, user-defined programming languages hold up all interactions inside a virtual world in the form of live programming. A full-body immersion environment, which is built using virtual worlds, scales conformally up to the unlimited number of hardware and software nodes. It could be involved in educational or artistic scenarios accordingly.

The prototype of scaled full-body immersion environment in an art-gallery space.

In this section, we will discuss the scaling of a CAVE (cave automatic virtual environment) in the case of an art gallery's educational space. Featuring the transformation of the whole gallery space into one multi-CAVE environment. The installation "A. Ivanov Biblical sketches" in The State Tretyakov Gallery (Moscow) and The National Pushkin Museum (Saint Petersburg) had used an early prototype of our CAVE system. The gallery's walls were transformed into virtual painting walls. In addition, a visitor walking with the controller in his hands emits a virtual light to the walls, spotlighting the virtual frescos. Six nodes (personal computers) form a CAVE in this prototype (Figure 1).

Figure 1: The CAVE prototype of the installation for the art-gallery

The software part of a CAVE system is our modified version of OpenQwaq/Open Croquet virtual world development kit: Krestianstvo SDK [1]. Open Croquet architecture is well suited for creating replicated virtual worlds, which are distributed over the network. Four nodes project a virtual world onto the cube walls. One node controls the user's movements in a virtual world. The last node is used for the setting the parameters of the CAVE system. Several running virtual machines and their corresponded virtual images with the source code in them define the replicated state of the computation – Island [2]. Live programming could be done from any node, as all nodes are equal to each other. An artist or teacher is working in a language browser, which could be opened just in a virtual world. Any modification in a source code is replicated immediately to all instances of a one shared Island. An artist is programming in Smalltalk/JavaScript programming language or in his own user-defined programming language. Scaling of the CAVE system with new nodes is done just by starting the new ones and connecting them to the running virtual world. An artist adjusts the properties of the whole CAVE system with his own avatar. In general, many existed CAVE environments and their corresponding software tools are based on the client-server architecture, thereby requiring the knowledge of an underlying model and communications protocols. The virtual worlds, which are based on the model of a distributed computation, like Open Croquet and Virtual World Framework, solve that problem by generalizing the model of communication. It is done by moving the model up to the virtual machine level of an existed programming language. So, that we could observe a conformal scaling from one node to many nodes, while omitting the use of the communication protocols during live programming.

An artist or a teacher gets the full-featured connected virtual/real space to manipulate within it. For example, it is easy to model an augmented light for the physical room. An artist can freely experiment with the transitions and effects of the virtual light source (Figure 2).

Figure 2: An experiment with a virtual light source

Move the light source in a virtual space while observing the visual effect on the real room's walls. Moreover, one could experiment with geometry transformations, like dividing, adding new virtual content. Then to project his distributed virtual space into the physical space in real-time. One could use Microsoft Kinect, DMX controllers, TUIO markers, etc. that are available for using in the virtual world.

The integration of the object-oriented language for pattern matching OMeta [3] onto Virtual World Framework allows us to define own language grammar on any virtual world's component and replicate it through all application instances. Then one could script that component with a predefined shared grammar. For example, one could have all the languages down from Logo (Turtle graphics) to Lisp, Smalltalk, JavaScript, even a gesture language of the body or hands movement. The scripting of the virtual world is available just in a Web browser in real-time [4]. A virtual world could contain many simulations running in it. These simulations could use the data, which is generated by the software, but also the data, which is gotten from any other external sources like hardware sensors or the internet. OMeta based user-defined languages will be a natural solution for parsing that incoming data in a natural way (Figure 3).

Figure 3: The screenshot from the Krestianstvo SDK virtual world

The prototype of a scaled virtual reality system in a classroom: math lesson.

We have built a Collaborative Curved Space Explorer (CCSE) as a full-featured multi-user toolbox for exploring a structure of curved spaces in 3D with the support of real-time rendering inside a CAVE system. Jeff Weeks originally developed the application known as Curved Spaces. This application is for exploring and rendering curved spaces in real-time for a single person, written in a C programming language. CCSE is actually the port of the C-language version of the Curved Spaces application into Smalltalk and Open Croquet virtual world architecture. The CCSE is based upon work partially supported by the Russian Foundation for Basic Research under the grant No. 07-0700332.

The prototype allows us to run complex simulations and to achieve a very deep level of collaboration in exploring curved spaces through full-body immersion. There is a default library of spaces to explore, but more curved spaces could be generated by SnapPea application, suited for creating and studying 3-manifolds. CCSE is programmed in the pure highly dynamic, reflective, homoiconic language Smalltalk [5]. It allows to change an object's behavior just in real-time. Users are flying with their avatars in a selected space collaboratively observing their own and others spaceships (Figure 4) inside CAVE automatic virtual environment system.

Figure 4: Collaborative Curved Space Explorer (anaglyph stereo screenshot)

Programmatically, virtual spaceships are running on different machines and are controlled by real users. Potentially there are can be any number of participants, observing self-transformations simultaneously in a curved space trough the web-browser application or self-built CAVE. End-users could control the simulation from a multi-touch table, which is also an instance of the same virtual world. Several such tables can organize a peer-to-peer network. All these becomes a real collaborative, interactive interface for a classroom, reprogrammable using live programming technique.

Conclusions.

The paper describes the prototype of the full-body immersion environment, which is running by virtual worlds. We discuss two scenarios: in the art-gallery space and in the classroom. Both scenarios use corresponding virtual worlds, which are running by six nodes and could be easily scaled up to any number of nodes. CAVE application uses our modified version of the Open Qwaq/Open Croquet/VWF virtual world development kit: Krestianstvo SDK. Open Croquet and Virtual World Framework architecture suits very well for creating replicated virtual worlds, which are distributed over the network. Several running virtual machines and their corresponded images with source code define the replicated state of the whole computation. Any modification in a source code is replicated immediately to all instances of it. An artist or a teacher could use his own user-defined programming language for live programming in a CAVE. This is possible due to OMeta (Object-Oriented Language for Pattern Matching) and Virtual World Framework integration. Scaling a CAVE with new nodes is done just by starting the new ones and connecting them to the already running virtual world. Using an avatar, an artist or a teacher adjusts the properties of the CAVE system, adds new geometric shapes and virtual content. All these makes the full-body immersion environment based on virtual worlds different from the standard software tool's based one. The learners share exactly their online activities and computation within a united simulation space. They interact with virtual world’s content by using real physical objects as controllers. The virtual world’s architecture takes everything on a distributed computation. Neither a teacher nor learners do not need to think about an underlying software program architecture while preparing their content and educational scenarios inside a full-body immersion environment.

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Supplementary Materials:

Figure 1: The CAVE prototype of the installation for the art-gallery

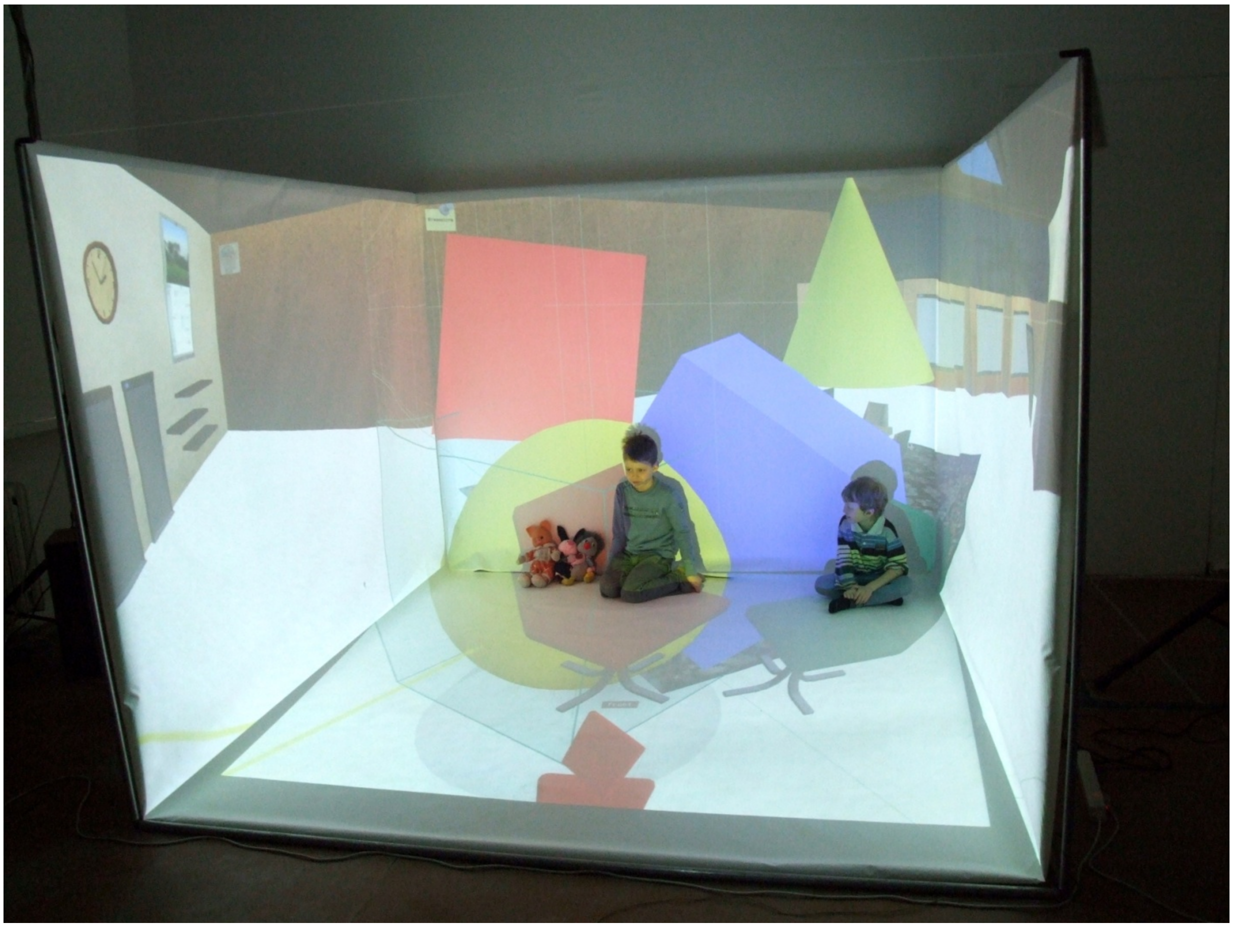

Figure 2: An experiment with a virtual light source

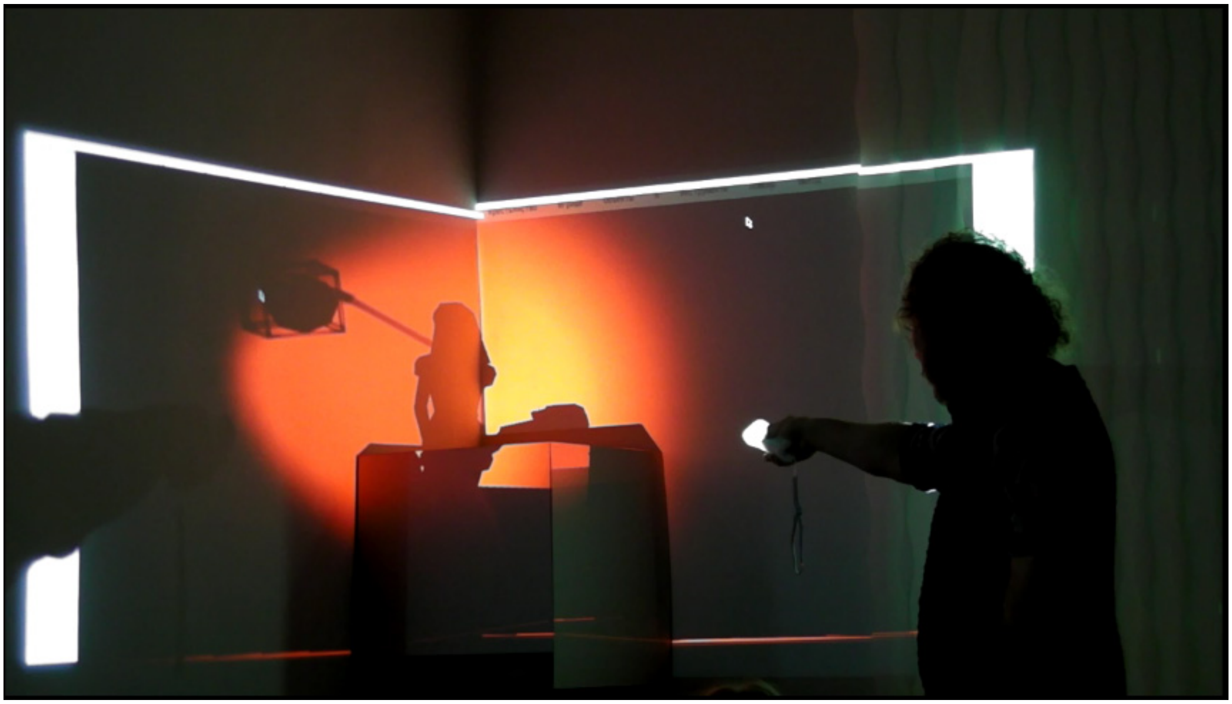

Figure 3: The screenshot from the Krestianstvo SDK virtual world

Figure 4: Collaborative Curved Space Explorer (anaglyph stereo screenshot)

13.

Virtual agents as support for practical laboratory activities

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Abstract:

Although education has always been present in people's lives, it has changed over time. Centuries ago children had a tutor to guide them in learning the arts of science, philosophy and war, but population growth has made this difficult to maintain.Today, virtual worlds (VW) provide new teaching and learning possibilities through creation, immersion in and manipulation of 3D worlds. Interaction with objects, other humans (avatars) and virtual gents (non-player characters or NPCs) in these 3D worlds can expand educational capabilities to provide one tutor per student. This study discusses the use of virtual agents to provide specific support for students in practical laboratory activities.

One Sentence Summary: This article discusses using intelligent agents in virtual words (OpenSim) to help acquire knowledge.

1. INTRODUCTION

Situations that are similar to the physical world (also called real life) can be created within virtual worlds. This means that a chemistry experiment in a laboratory or training sessions in sales or the maintenance of industrial machinery can be simulated in order to safeguard participants' physical integrity, save money and shorten learning times. Virtual worlds can exchange data with learning management systems, enterprise resource planning, legacy systems, databases and Web systems. These exchanges allow information to be sent and received regarding simulations and the users executing them. As such, user data can be fed into virtual agents to monitor user performance in learning activities. Virtual worlds offer a combination of simulation tools, a sense of immersion and opportunities to communicate and collaborate. As such, they have significant potential for application in education. In addition, virtual worlds make it possible to create manageable representations of abstract entities, thus helping students to construct mental models through direct observation and experimentation. Technology currently provides free software, such as OpenSim, to run virtual worlds. The present study analyzes the features needed to create an interaction- rich learning environment, whereby students carry out practical tasks in laboratories while learning and studying and receiving support from virtual agents.

This paper is organized as follows: Section 2 provides a general overview of the learning tools in virtual worlds and section 3 contains the conclusion and prospects for future research.

2. Learning tools in virtual worlds

The ability to dynamically interact with reality offers a wide range of possibilities in terms of developing learning solutions by better contextualizing real tasks. This can stimulate students' ability to solve more complex problems since input data come from devices that capture information and signals directly from the real world. Processing and handling this vast amount of information requires students to use all their accumulated knowledge on a specific topic through experiences made possible in the virtual world.

In order to understand their resources, virtual worlds must be explored. According to Nelson [1], a virtual world can be explored in the first person or using an avatar (third person):

(1) in a first person virtual world users experience the environment as if embedded in it. They see the virtual world through their own eyes, or rather those of their avatar, which is a visible or invisible representation of their character. In a first person virtual world users' avatars can be anything from a 40-foot giant to a snake slithering along the ground, but they never actually see themselves: users can only see the world that it is front of the eyes. In commercial video games, this form of visualization is standard in first person shooter (FPS) games.

(2) in third person exploration of a virtual world users control a visible avatar and move it through the world. Almost all massively multi-player online role-playing games (MMORPGs) use avatar-based third person controls. Users spend most of their time in third person virtual worlds looking at the back of their avatar as its moves around the environment. The only time they are likely to see their avatar is when they choose the character at the beginning of the game, when it dies, or during "cut-scenes" (short sequences designed to progress the story).As such, avatars are natural inhabitants of the virtual world. They are the personification of humans in 3D virtual settings and can take on whatever shape or appearances users desire.

Since people can be physically present in a virtual world through an avatar, it becomes their representative and means of interacting with the environment, especially when users have educational goals. As described in [2] and [3], avatar design can influence users' psychological connection to their avatars and the education-related outcomes of their use. In addition, the relationship between humans and avatars may imply that education-oriented virtual worlds should encourage a body-level connection to avatars by personalizing them, for example. According to Scott [4], when avatars are used as a motivational tool are most effective when using more powerful and evocative communication channels: verbal communication via text and visual through expressions. Rahman [5] presented avatar-centric interpersonal virtual communication events as a form of haptic stimulation for real-world users, since touch is important in technology mediated by human emotion, communication and interaction.

In this proposal, virtual worlds communicate with a web service attached to a hardware component that stimulates interaction (touch sensitive). This approach can be used for laboratory experiments.

Another significant component in virtual worlds are the objects available for manipulation, referred to as prims. Prims can be simple items such as a table or TV screen for video presentations or complex entities constructed by integrating basic prims or externally modeled objects. Any prim can have a script governing its behavior and reactions when touched by an avatar or when close to one. Scripts in OpenSim can be developed using LSL (Linden Scripting Language) or OSSL (OpenSim Scripting Language) [6]. LSL was originally developed for the virtual world Second Life.

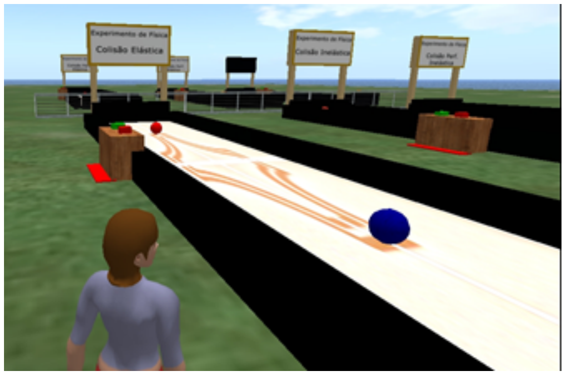

Figure A: Collision experiment

Figure A shows a scenario in a physics learning laboratory, where students work on experiments aimed at eliciting certain behaviors from objects involved in elastic and inelastic collisions. This is an example of an experiment designed by a student with programming skills.

Figure B: Virtual environment designed by an undergraduate student

Figure B depicts a virtual environment developed by an undergraduate student with no knowledge of programming. In this virtual scenario students designed an environment to present multimedia learning resources they developed using external tools (images, presentations, videos).

Creating artifacts for virtual worlds requires a degree of familiarity with programming language. Those with little digital fluency produce less sophisticated items. It is believed that students are highly motivated in these endeavors because they provide an opportunity to develop e-learning lab activities without the need to relocate to centers where real resources are available for experiments. Other studies also highlight the effectiveness of digital laboratories as a learning resource. Dalgarno [7] proposes a simulated setting to increase student confidence and reduce anxiety through pre-laboratory activities developed using Virtual Reality Modeling Language (VRML) conducted prior to task in physical labs. Schaf [8] suggests an architectural plan for Computer Supported Collaborative Environments (CSCE) consisting of remote and virtual laboratories to improve learning and autonomy and support conscious collaboration. The author presents three cases: (1) implementing a multi-agent system (MAS) to monitor laboratory experiment bookings (using PHP, MySQL and Jade), (2) using OpenSim to associate objects in the virtual world with reality and simulation equipment (with LibOpenMetaverse (lomv) and XML-RPC) and (3) using lomv to create automated NPC with the autonomy to respond to objects, interventions by other avatars and chat commands in laboratory activities. Along these same lines, Pirker [10] describes the implementation of TEALsim (a three-dimensional framework to improve students' understanding and conceptualization of physical phenomena) in the virtual world OpenWonderland. Thus, the authors created the TEAL virtual world to give students the opportunity to visit online learning courses use the TEAL learning approach to improve their understanding.

2.1 Communication in and outside virtual worlds

Creating objects and writing scripts are part of laboratory construction, since both these elements are needed to enable communication with other objects in virtual and/or physical worlds. A series of protocols are needed to allow this communication, which in virtual words is typically accomplished in two formats:

(1) Chat – as mentioned above, chat boxes allow users to write to other avatars, non-player characters (NPCs) or objects, and

(2) Touch – this occurs when avatars click on an object with script that executes an action. In Second Life, a touchstart event is triggered by an agent clicking on a task. Both formats use zero for the public and channels 1 to 2147483647 for private messages [1 1].

According to Tibola [1 2], there are several ways to allow external applications to communicate within a virtual world: (a) an HTTP request to a Web service, where a prim sends a request to the Web service, which processes it and sends it to OpenSim, (b) an HTTP script call that runs a remote script program to manipulate data in a database, which can become part of an HTTP query string or another format, when necessary, (c) XML-RPC: enable two-way communication between the virtual and physical world through remote procedure calls and XML data transfer. This approach enables external programs to be run, such as Java, C ++ and C # to send and receive data. An external program can execute an LSL / OSSL script in a prim in OpenSim through XML-RPC "libs" (libraries). HTTP resources can also run websites and as such, a prim can be configured with a URL and display the page via this link. This resource allows the execution of other media, including video.

Support 2.2 Support in immersive environments

Working in a virtual world that aims to imitate an actual laboratory is not easier than doing so in the real world. Though not faced with the risk of mistakes, e-learning students can become frustrated if the lack of proper support prevents them from successfully completing a task. Thus, it is advisable to provide a substitute for human supervision, capable of guiding, assisting and providing feedback for students working in the virtual laboratory. One solution is to provide each student with a dedicated tutor (virtual agent) in the form of an NPC or non-player character, which can be part of an immersive environment and resemble the avatars that represent human users.

Tetyana [13] proposes an adaptable model to control the behavior of NPCs consisting of a set of possible internal and external factors. Internal factors correspond to the needs and natures of the NPC (for example, the requirements and purpose of the desired educational experience) and external factors refer to the nature (cognitive parameters) of the player. Depending on internal (what needs to be done) and external factors (what the user has already done), NPCs can react uniquely to each stimulation received or perceived in the environment. Ranathunga [14] studied the connection between cognitive agent platforms such as belief-desire-intention (BDI) programming frameworks and Second Life . The author presents a framework that facilitates the connection between any multi-agent platform and Second Life and demonstrates it in conjunction with an extension of the Jason BDI interpreter.

NPCs can be inserted during specific action taken by the student's avatar, such as: touching an object, typing a message in a specific chat channel or simply passing through an area. This is possible due to the presence and configuration of sensors throughout the virtual world, which detect the presence of the avatar and trigger specific actions, which enable a series of interactions with the student. Scott [4] argues that avatars can be used as a motivational tool, enabling verbal communication similar to human communication.

The following scenario provides an example of interaction: when a student's avatar approaches a door, it opens automatically and an NOC appears to welcome the student and present an experiment. The NPC then asks the student to follow it to a certain position, where a video on the experiment is available. It simultaneously provides information on the video and the experiment, enabling the user's avatar to converse with it. Not only is this scenario possible, but all interactions can be collected and stored in real time in an external database to provide a record of the activities performed.

Similarly, NPC behavior is also governed by scripts. The incorporation of scenarios, objects and avatars (bots, non-player characters) with scripts allows programmers to personalize reactions that users receive in the virtual environment when working through their avatar. An NPC can track user interactivity for the purpose of guidance, support and assessment. OpenSim suggest a number of functions to create and manipulate an NPC [6]

using a set of OSSL functions. In order for certain functions to be executed in OpenSim (such as creating or removing an NPC, etc.), they must be enabled in the desired area by configuring the "OpenSim.ini" file. An advantage of this approach is that an external client is not needed to create and manipulate an NPC and its appearances can be saved in OpenSim files (.OAR extension). A drawback is that there is a limited subset of resources available and a set of programs must be written to control different aspects of an NPC. Another limitation is that these NPCs cannot move outside the area in which they are created [6].

Designing and implementing these entities requires an analysis of the technological possibilities in the virtual world in question, in order to introduce features and mechanisms that enable the productive participation of these characters in the desired teaching-learning situation. Incorporating greater intelligence and social behavior into the NPC makes the virtual world more appealing. This is because environmental reactions become more intelligent, adaptable, personalized and therefore more effective and engaging, as proposed by Soliman [1 5], who proposed the development of Intelligent Pedagogical Agents (IPAs) in immersive virtual learning environments. IPAs are autonomous software agents with educational purposes. Their functions include providing guidance and tutorials, finding learning resources, monitoring student progress and assisting in collaborative and communicative learning functions. Their main objective is to provide intelligent, conscious and educationally personalized student-environment interaction. As such, it is important for IPA integration in the immersive environment to facilitate these functions. Soliman [1 5] extended the potential of IPAs using an additional belief-desire-intention (BDI) model for reasoned action.

2.3 NPC technical behavior

A non-player character (NPC) should act in the same manner expected of a human; otherwise, the experimente will appear less realistic and engagement declines. In the gaming industry, artificial intelligence techniques have been used to direct the behavior of NPCs. The programming required to achieve this type of reaction is highly complex.

The availability of chatterbots outside the virtual environment to support learners [17 support learners [17] can be used to simplify the strategy of developing software to regulate the behavior of virtual agents. Chatterbots can be specialized in subject areas with knowledge bases focused on themes relevant to the educational activity being designed for the virtual world [18,16].

Soliman [19] and Sgobbi [2 0] reported that pedagogical agents are intelligent learning support agents in “virtual learning environments” (VLEs). Use of a multi-agent system inhabited with intelligent virtual agents has been shown to provide a number of learning benefits. In his study on intelligent agents, Sgobbi [20] observes that intelligent agents improve learning possibilities and show educational value, as well as demonstrating new learning possibilities. In order to achieve this objective using agents in a distributed learning platform, the paper assesses intelligent agent development frameworks. This evaluation will provide valuable information for those who use and integrate intelligent agents for different types of VLEs with a view to creating new learning scenarios.

The Pandorabot platform was used in order to establish a connection between an NPC in OPENSIM and a chatterbot [24].In this setting, a chatterbot must be created and made public in Pandorabot to be usable as an extension of the NPC. In the OpenSim environment the NPC was created and scripts were developed to configure the connection with Pandorabots:

```
state_entry ()
{ gOwner llGetOwner = (); cust = ""; BOTID = "a77ebb73ce343648";
llListen (0, "", NULL_KEY, ""); }
```

Figure C: Coding used by the author to identify the chatterbot

In the above script, BOTID is the identification of the chatterbot in Pandorabot and results from the process of creating the entity. Communication is subsequently completed by linking the object with the Pandorabots database.

```
link_message(integer sender_num, integer num, string msg, key id)
{requestid = llHTTPRequest("http://www.pandorabots.com/pandora/talk-xml?botid="+botid+"&input="+llEscapeURL(msg)+"&custid="+cust,[HTTP_METHOD,"POST"],""); }
http_response(key request_id, integer status, list metadata, string body)
{ if (request_id == requestid) if (msg == "/create"){listen_to(id);}
```

Figure D: Coding used by the author to link the database.

In the above scripts, the NPC is created and fully connected to the Pandorabots database. It will send all the messages received from the user to the chatterbot and then present the answers provide by the latter. Chatterbots are customized to a specific context by changing its knowledge base expressed using AIML (Artificial Intelligence Markup Language).

2.4 Behavior of the virtual agent

The virtual agent, implemented using NPC technology, and the chatterbot in fact form a set of agents specialized in supporting leaning activities along the virtual route designed for the student. Figure E shows a scene from a virtual world where users interact with the virtual agent through a chat box.

Figure E: Student avatar interacting with a virtual agent

Initially, the role of the virtual agent is to guide the student in the activities to be performed. Once students feel comfortable about beginning the planned activities (experiments, for example) in the virtual world, the virtual agents offers advice, answers and explanations on the resulting data. In the second phase students are prompted to reflect on what they experienced in the virtual world, as recommended in Kolb's experiential learning cycle [2 2].

The virtual agent is supported by a chatterbot that extends interaction flexibility with minimal additional programming, since the knowledge base can be expanded by simply editing the AIML. These files store the knowledge base that supports the chatterbot's capacity for dialogue. In order to evaluate the prototype implemented in the environment, a survey was conducted among specialists and regular users regarding their opinion of the proposed solution. Respondents were asked to evaluate the prototype and give their opinion regarding the virtual agent's ability to provide useful resources that support learning. Participants were undergraduate students who use computers for educational purposes and potential users of the virtual world designed. The answers, summarized in Table 1, show students' expectations regarding the use of virtual agents such as those in the prototype to provide educational support in virtual worlds.

Question	D	PD	N	PA	A	Weighted mean	S	SEE
Q1- The virtual agent is capable of providing useful guidance to support activities executed in the virtual world	2	1	1	7	8	3.95	1.31	0.52
Q2- Interaction with the virtual agent is in line with the student's pace	2	1	3	8	5	3.68	1.25	0.50
Q3- The virtual agent provided assistance when asked	2	4	2	8	3	3.32	1.29	0.51
Q4- Interaction with the virtual agent prompted new ways of thinking about the subject	2	1	3	7	6	3.74	1.28	0.51
Q5- I was able to use the virtual agent without much difficulty	0	3	1	11	4	3.84	0.96	0.38
Q6- I believe this type of support could be offered in other areas of knowledge	0	1	1	5	12	4.47	0.84	0.33

Table 1 – Evaluation of the agent's possible contribution in the virtual world

Legend: D (1) = Disagree, PD (2) = partially disagree, N (3) = Neutral, PA (4) = partially agree, A (5) = agree; S – standard deviation for the sample

SEE – standard error of the estimate (95% confidence level) using Student's t-distribution

The results indicated that most interviewees (83.3%) recognized the potential of the virtual agent. Question 3 showed the lowest level of agreement regarding the virtual agent's ability to provide answers (68.42%).This is explained by the fact that the prototype does not yet have a sufficiently comprehensive knowledge base. The experiment is a work in progress that continues throughout the use of the environment. Any questions from the user not adequately answered by the virtual agent are recorded and the team responsible will continuously add knowledge to the chatterbot AIML base that supports its ability to dialog with users. Once this file is expanded the virtual agent will have a broader knowledge base, making it more capable of natural and effective dialogue with users.

Question 6 exhibited the greatest agreement concerning the virtual agent's positive support potential. This result reflects a positive and optimistic view regarding the use of this type of resource sin other areas.

Conclusions

Virtual world technology offers a wide range of possibilities in terms of designing 3D learning objects. The OpenSim system was chosen due to the advantages it provides.

This study demonstrated the possibilities and limitations of a virtual world, such as OpenSim X Chatterbot, in implementing interactions with elements constructed within it.

The characteristics and potential uses of virtual words were presented, describing relevant studies as well the process of creating an NPC and its communication in and outside the virtual world. The outcome of prototype tests were also presented. Research and the results obtained demonstrated the multitude of viable communication methods possible between virtual words and external applications; the manipulation of databases is another possible means of exchanging data in this environment. As such, even legacy applications can be used in virtual worlds by accessing the worldwide web or through web server.

Establishing the feasibility of connection opens a wide range of possible applications for virtual worlds with a real world context and intercommunication between the real and virtual world.

In conclusion, we have shown that virtual worlds can provide a unique opportunity to improve e-learning, enabling active learning and the use of virtual laboratories that are especially relevant in promoting complex learning.

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DEMONSTRATIONS

01.

Floating in the Middle of the Soccer Field. An Immersive Education Initiative for Being Present into the Scene

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Abstract:

The aim of this paper is to propose a method to experience a free-viewpoint video and image with a head mounted display (HMD) and a game controller which enables to interact intuitively. The free-viewpoint video is generated by multiple 4K resolution cameras in sport games such as in the case of soccer or American football. This method provides the user a player's perspective as if they were in the middle of the field.
We used a "bill board" and "point cloud" method to produce a free-viewpoint video which consists of multiple textures arranged according to the user's position in the scene. We used a game development system and a HMD in order to implement and display the images.

Moreover, we used a game controller to allow the user to move in the scene and to change their point of view with a high degree of freedom.

One Sentence Summary:

Our technology provides a new way to analyze movements of players and a strategies of a real soccer game for sports education.

Introduction

Usually the viewpoint is fixed when the images are taken from a unidirectional video source, such as in the case of the classic television broadcast or in the video streaming. To solve this restriction, the free-viewpoint image, which is the well-known novel three-dimensional (3D) viewing system, has being developed and it is adopted by few television programs. Presently, the free-viewpoint video technology has been studied on mainly 2D flat displays where users can chose the view point. However, there are two major inadequacies of the existing researches: firstly, previous researches cannot achieve 360 degrees free view with their own devices such as the players' perspective. Secondly users can hardly experience immersion such as in a virtual. We have studied free-viewpoints videos for sports games being held in big spaces. Therefore, our technology is directly studied for games such as soccer or American football, even if it is not limited to them. Our work is realized in order to be visualized on tablet terminals and to be synchronized with television broadcasts and our long-term plan is to build a system which includes capturing, displaying, sharing and editing free-viewpoint contents over multiple platforms in real-time, such as mobile devices and TV.

We are developing this system thanks to the process of managing multiple different types of data in the computer library *OpenMV*. This library stores movie textures or images, depth data, camera parameters and frame time information which are captured during the soccer game. When users start to display a free-viewpoint video, information such as players' ID, positions and the direction of movements will be visible on the display.

Method 1: for generating free-viewpoint images

This section describes the details of generating the free-viewpoint video displayed on the HMD devices.

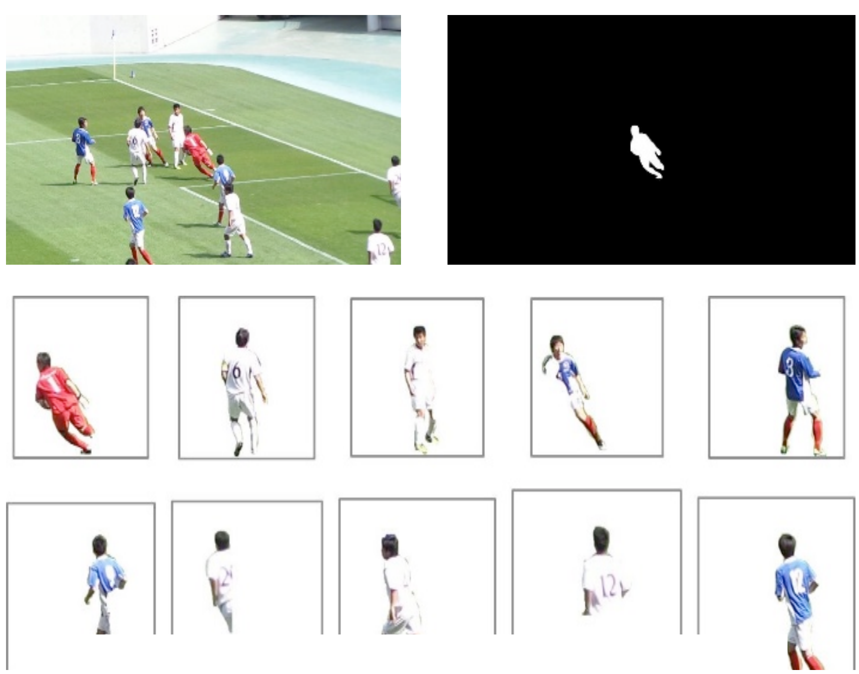

Figure 1. **Cropped images of the players with alpha channel.**

Basically we use a bill board system, which was proposed by H. Saito [1] [2], to generate the free-viewpoint video.

At first a soccer game in the auditorium is captured by four 4K resolution cameras and our system automatically extracts texture data of players using segmentation of the regions as shown in Figure 1.

We use a laser range scanner which can accurately measure player's positions in the large area by horizontally projecting red laser lights and measuring the time the lights require to be reflected from the objet. The acquired distance and angle captured by the device identify the exact location of the players as coordinates for mapping process in the *Unity3D* [4], which is a game development tool to create interactive 2D and 3D contents.

These textures are processed in *Unity3D*. We build bill boards for each player and we place them in a virtual soccer stadium model by attaching them the image texture. Player's texture data of a specified viewpoint are interpolated by the nearest real camera view-point and then mapped on the bill board.

We use a *Flash Lidar* camera to capture 3D figures of players and their locations and these data are translate into "point cloud" format in order to allow *Unity3D* project scene to display them correctly. We add color information from RGB cameras to those point cloud models (Figure 2) and finally we manage to insert a 3D model in the scene oriented in the way we like. The extracted data are stored in a server and they are read when users activate the system.

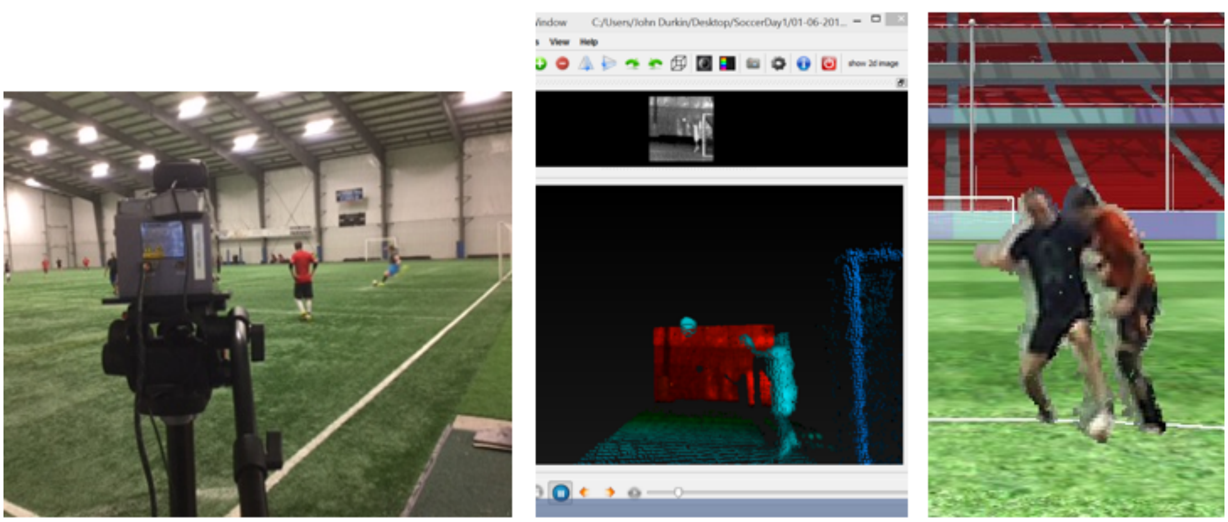

Figure 2. Flash Lider camera and its point cloud and display as 3D model in *Unity3D*

Method 2: for devices

We use the HMD *Oculus Rift* to simulate the view of each player. Oculus Rift has head tracking sensors which can help users to see a video following their head rotation and it provides stereoscopic 3D display via dual lenses. Users can easily experience 3D videos with the HMD which makes it possible to immerse themselves into the soccer field. Moreover, the subject is free to move into the scene thanks to a game controller. An application developed in *Unity3D* for *Oculus Rift* would be running on a PC and Figure 3 shows the experience an user would have wearing the HMD.

Figure 3. With Oculus Rift and Nintendo Game pad

Figure 4. An example of "bill board" model players on *Unity3D*

Although few computer games can generate first person view contents, our technology allows a free-viewpoints thanks to multiple synthesized cameras which capture the real dynamic scene, such as in the case of a soccer match.

Evaluation and Discussion

Displaying the scene with *Oculus Rift* enables users to have a 360-degrees view. Figure 4 shows an example of a game window. We observed that users can feel their own virtual position in the scene more accurately and instinctively. The most innovative point this technology introduces is the possibility to experience the game as if the subjects were part of the scene and located in the middle of the field, among the players during the match. Although 3D and VR video could cause sickness, being able to move and act from a localized point of view can reduce this kind of side effects. We encourage people to join the demonstration and experience by themselves.

This technology is used to allow the subject to live in the middle of the soccer field during a match. However, its potentialities are not limited to this kind of use only. By allowing the subject to be immersed in another place captured by cameras, it allows them to be projected into another place of this world, or at least in another place where it is possible to have cameras. As soon as we are able to reduce the time we need to elaborate the data and we manage to have an experience in real time, it will be possible to project subjects among different places just by switching the devices on and off.

This is a complete new way to explore the scene because we have not to make use of physical objects placed into the scene, such as robots which "mimic" the subject's presence and which embed the subject's will [3].

Therefore, it is a useful tool for students and teachers to have a direct experience as if they were present during the salient moment of an important event and where external objects like robots are not allowed.

This technology has been developed to allow students and teachers from whole the world to be present in the middle of the field of Tokyo 2020 Olympic Games. Thanks to this technology it will be possible to allow them to be projected in the middle of the field and to be part of the game as if they were playing side by side with the real players without intrusive technology which are not allowed in the games.

In this way the students will have a direct perception of the game and such experience will allow them to better understand the tactics used and the organization of the players in the field. Teachers too will have the possibility to improve their knowledge about the game and to develop a new way of teaching based on this new possible experience because this technology makes the direct experience of a distant event possible.

Conclusion

In this paper, we proposed a new method to experience free-viewpoint video generated by multiple 4K resolution cameras. Thanks to our method the free-viewpoint video has been improved in respect of its immersivity and its intuitiveness.

This system can be widely applicable for any entertainment companies which are aiming to higher-presence feelings or for some sport research facilities which are working on game strategies or players training.

Our technology makes the direct experience of a distant event possible. Therefore, it allows students and teachers to be present in the middle of the event and to see with their own eyes what it is happening.

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Tetsuya Kawamoto worked on the second and third sections of this work. Nicola Liberati worked on the first and fourth sections.

03.

Title: Designing a 3D Virtual Reality IES (Imaging, Evaluation and Suggestion) Diagnostic System

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ABSTRACT

Thoughts are abstract and difficult to express and even more difficult to portray. This work in progress project, aims at delivering a New Age IES system (Imaging Evaluation and Suggestion system) with a focus on understanding and monitoring the neural correlates of the working brain, cognitive processes and (visceral) thoughts, in a tangible manner.

Going by the alpha name 'ThoughTouch', the idea is to build on a customized 3D CAD modeling based tool interfaced with a wireless EEG input device. Applying machine learning techniques, the data acquired from 'ThoughTouch', will help us to decipher, analyze, visualize & compare better non tangible concepts such as learning using 3D printer integration, and help in predicting/ detecting the individuals having below threshold cognitive abilities i.e. in classroom scenario early on which individuals are having/will have trouble with various courses so that the lessons or the course can be adjusted according to their cognitive abilities.

Summary: To create an integrated imaging, evaluation and suggestion system that will help to understand the cognitive capacity of individuals of varying academic performance via Gestures-BCI integrated 3D imaging.

Keywords – Electroencephalogram (EEG), Brain Computer Interface (BCI), Autism, Cognition, Machine Learning

1. INTRODUCTION

Cognitive ability plays an important role in learning various sensory and non-sensory skills along the developmental trajectory. Currently, there are no such intelligent mediums available to measure the cognitive abilities of the individuals studying at the same academic level. Though, the individuals are forced to study the same curriculum in same class, but the mental abilities of all individuals are not same. Hence, in this present attempt, we have conceptualized and developed an EEG based intelligent IES system for the easy diagnosis of the mental ability of various individuals. EEG is a non-invasive method to record voltage fluctuations of the brain. EEG records voltage fluctuations on the scalp, resulting from ionic current in neuronal level of the brain.

The key objectives of the proposed research are:

1. To create a real-time spatio-temporal brain picture of the brain in action
2. To understand the cognitive abilities of individuals from various socio-economic background.
3. To suggest the right curriculum or mental load based on the evaluation of their cognitive capacity.
4. Create a tool that moves beyond the traditional cumbersome, radioactive and contrasting agents based imaging systems, generally involved for such research purposes and create a cost effective, user friendly and fast system for multi dimensional imaging.
5. Further, this project aims to create a tool that will help to understand the learning challenges and the thought process of intellectually challenged people suffering with autism (more particularly the non-verbal autistic children).

2. OVERVIEW

Our research aims at creating a new age low cost 3D imaging solution with a focus on imaging 'thoughts' and inner working of the brain in a tangible manner. Along with features like 3D printer integration, ‘ThoughTouch’ seeks to be not just an imaging system but also an evaluation and suggestion system. With machine learning based predictive evaluation integrated, it can help analyze various outputs proactively, give remedial suggestions and add to its overall meta data information regarding certain paradigms.

Our aim is to use EEG based BCI(Brain computer interface) device inputs and interface it to a scalable 3D modeling system that sculpts a raw 3D cube and converts it into a 3D mesh based output, so that we can get real time 3D images of the inner thoughts of a human brain.

Moving beyond structural aspects, the 'ThoughTouch' machine learning based evaluation system not only evaluates the data but also suggests various ways for improvement, including possible ways for improving learning performance, altering thought processes for early intervention (including for the target people with special needs) and customizing delivery of say learning content and stimuli based on what suits best at that particular juncture for a particular individual. The machine learning program helps the system understand what thoughts are going in an individual in real time with a focus on, lower and higher abstract thoughts, and set evaluation parameters based on data captured of high performing individuals and see how they compare with the rest of the sample population and set ideal paradigms for suggestions.

2.1 Creation of Three-Dimensional Images

Traditionally CT and MRI scans produced 2D static output on a film. To produce 3D images, many scans are made, then combined by computers to produce a 3D model, which can then be manipulated by the physician. 3D ultrasounds also are produced using a somewhat similar technique.

Recently, techniques have been developed to enable CT, MRI and ultrasound scanning software to produce 3D images for the physician, using the same principle. These provide structural data but limited to no inner functional details.

Measurement and recording techniques which are not primarily designed to produce images, such as electroencephalography (EEG), magnetoencephalography (MEG), electrocardiography (ECG), and others represent other technologies which produce data susceptible to representation as a real time **parameter graph** vs. **time** or **maps** and other statistical data which contains information about the measurement locations. However in terms of a standalone imaging solution their output provides limited visualization.

Thus through our project we create a first of its kind **actual 3D imaging** system rather than one that creates 3D images by superimposing many 2D images.

Besides the project also aims to understand better, thoughts of those with 'non-verbal autism'. It is estimated that about 25% of people diagnosed with an autism spectrum disorder could be considered to have nonverbal autism. One of the strangest aspects of nonverbal autism is the fact that no one really knows why some people with autism can't - or don't - use spoken language. Some people with autism also have childhood apraxia of speech, a neurological disorder that makes spoken language extremely difficult. But many nonverbal individuals on the autism spectrum don't have apraxia -- they just don't speak. Clearly, there are differences in brain function that inhibits spoken language and 'ThoughTouch' seeks some answers to that.

The machine learning program helps in closely analyzing information of the high performing population in the sample and how learning is altering the inner working of the brain. The various information collected via 3D computer models and 3D printed models, helps us to compare them and gather discernible data for people across a spectrum of IQs, academic performance and those with the condition of non verbal autism.

Figure 1: Significant Difference observed in the Academically High Performing vs Academically Low Performing Individual while interacting with Thoughtouch

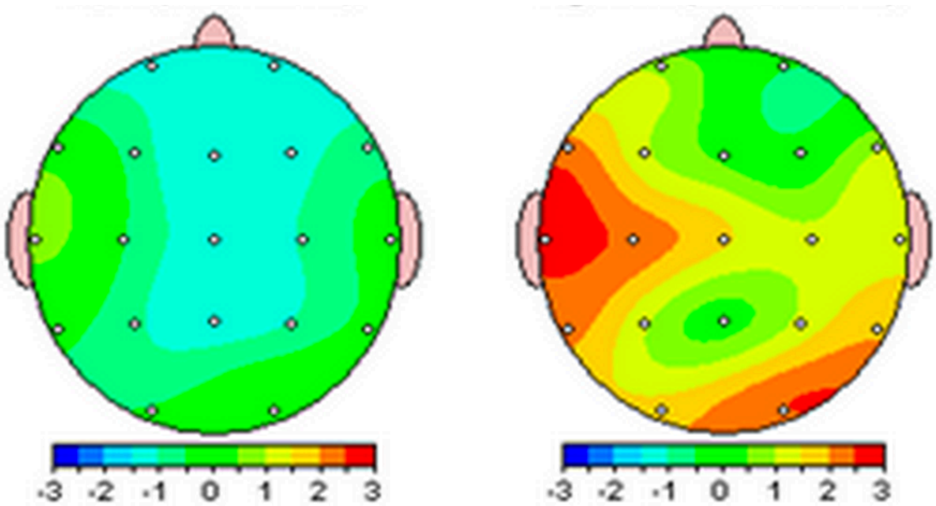

Figure 2: Comparative Brain map Output of Academically High Performing vs Academically Low Performing Individual while interacting with Toughtouch

2.2 Objectives of the project are:

- To provide tangible expression to inner working of the human brain especially help in conceiving 'thoughts' (including visceral thoughts) with a focus on using EEG based inputs.
- Provide plugins integration to help scale up the system easily, including with the likes of Microsoft Hololens, for better visualization features.
- Avoid big sized, cumbersome to maintain film based reports as outputs.
- Easy integration with 3D printers through a mesh based output to provide discernible expression to inner workings of the brain.
- Understand inner processes of the brain better including how 'learning' happens by monitoring tangibly changes in thoughts and see how learning is actually happening in a person and molding the 'plastic' brain.
- Monitor the 'Lateralization of the Brain' live in function if possible.
- With a focus on understanding thoughts and learning, to possibly improve learning outcomes, through a machine learning backend analytics system and to help analyse & compare better students learning in the classroom by comparing various tactile outputs as well as set certain paradigms.

- Being a low cost imaging solution, possibly integrate it to classroom learning in future and apply machine learning to the imaging solution to predict early on which individuals are having/will have trouble with the various courses so that we adjust the lessons accordingly.
- With a focus on non verbal autistic in the people with special needs category, understand better their thought process and what exactly goes on in their mind in different situations.

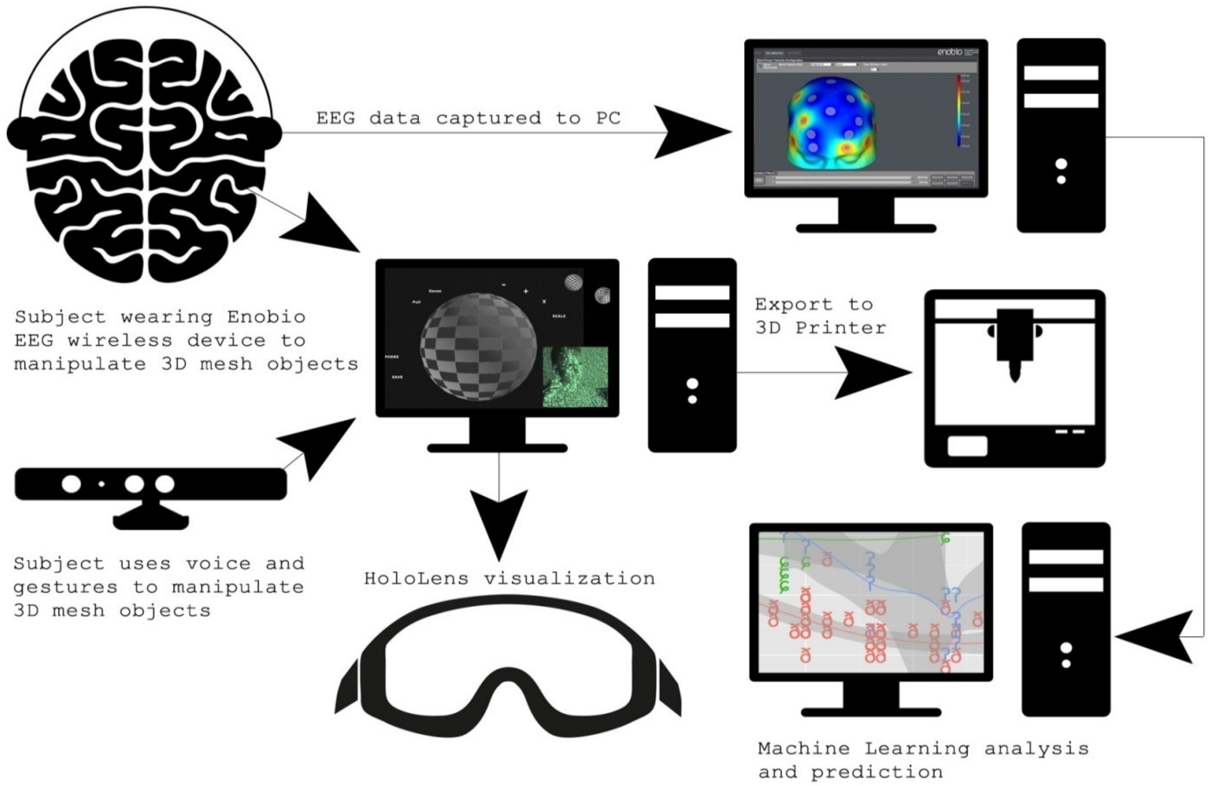

Figure 3: The 'Thoughtouch' Pilot Setup Overview

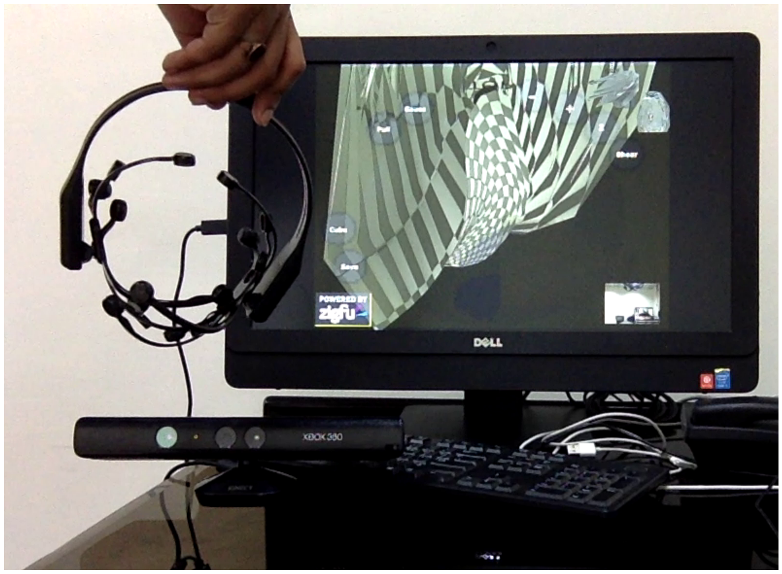

Figure 4: The 'ThoughTouch' Lab Setup

3. THE EMOTIV EEG INTERFACE (14 channel)

For the pilot project we are using a Sequential sampling 14 channel Single ADC Emotiv Headset. With a sampling rate of 128 SPS (2048 Hz internal) and resolution of 14 bits 1 LSB,

it has a dynamic bandwidth range of 0.2 - 45Hz with artifact resilience allowing for faithful recording including for Spectrogram and 3D visualization in real time of spectral features.

Dynamic range (input referred) is of 8400μV (pp) with built in digital 5th order Sinc filter for maximum impairment of noise.

4. SOFTWARE & HARDWARE COMPONENTS

- Unity3D Game Engine Environment.
- Emotiv wireless headset containing 14 EEG Channels

- TCP/IP data stream using the MatNIC Matlab toolkit for remote control at sampling bandwidth from 0-125 Hz in various bands.
- In house codes for signal processing and machine learning.

5. RESULTS AND CONCLUSIONS

Presently, we have developed a very basic 3D CAD model and interfaced it with Emotiv 14-Channel EEG system. EEG signals were recorded, when a person was actively involved with manipulating the CAD model. The acquired signals were processed and analyzed using sophisticated machine learning tools. In our pilot studies, the interface is working well. We need to collect more data from the target population for the evaluation and standardization of our proposed system to closely analyze information of the high performing population in the sample and how learning is altering the inner working of the brain. The various information collected via 3D computer models and 3D printed models, helps us to compare them and gather discernible data for people across a spectrum of IQs, academic performance and those with the condition of non verbal autism.

Integration with a 3D printer and the planned integration with Microsoft hololens, takes the interaction and understanding of the thought process to a multi modal level of interactivity, currently missing in most diagnostic imaging systems.

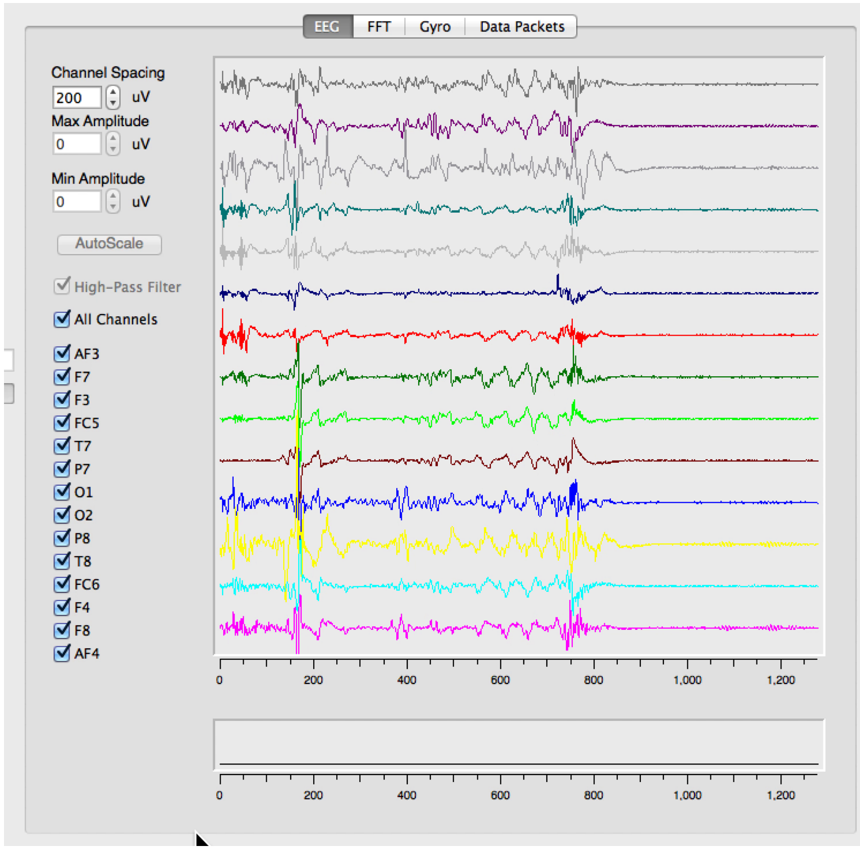

Figure 4: The 'Thoughtouch' EEG machine learning evaluation output

6. DEMO EXPERIENCE

- We give a live demonstration of Thoughtouch, including a hands-on experience of the hardware and showing the aggregated system via a video.
- We demonstrate the various outputs that the system is capable of giving.
- We show examples of certain captured preset paradigms.
- We provide statistical data of how the machine learning program helps us evaluate and suggest remedial action with a focus on improving learning outcomes based on the certain preset paradigms.
- We illustrate how the system can help in understanding non tangible brain related concepts, as well as how we can provide additional insight into the cognition process of people with special needs such as the non verbal autistic.

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04.

Title: Go for the Glow! – An Entertaining Approach to Training Foundational Life Skills

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[1]Vernée Ho is the Co-founder and CEO of Playto (creator, developer, and publisher of GlowMaster). She has more than twenty years of experience leading strategic business development and marketing initiatives across the Asia Pacific marketplace for companies such as Pepsi and Sara Lee. She holds degrees from Brown University and the Stanford Graduate School of Business.

[2]Douglas Glen is Co-Founder and Chairman of Playto. He led and pioneered several companies including serving as General Manager of LucasArts Entertainment, President and Founder of Mattel Media (online division of Mattel Toys), and CEO of Imagi Studios (animation). He also served on the founding board of Harmonix, the co-creator of Guitar Hero and Rock Band. He holds a degree from the Massachusetts Institute of Technology.

[3]Ann Bridgewater is Co-Founder and Clinical Psychologist of Playto. She also serves as a Clinical Psychologist at Central Health Partners in Hong Kong. Over the past decade, she served as department head of Hong Kong's Child Development Centre and specializes in pediatric learning disorders. She holds degrees from Hong Kong University, The Hong Kong Polytechnic University, and Walden University.

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Abstract: GlowMaster is a highly engaging video game and a training course that helps students master their focus through play. GlowMaster employs a brainwave (EEG) sensing headset to continuously monitor focus levels while onscreen graphics reinforce improvement in focus skills. Students are self-motivated to play the game for its compelling graphics, challenging play mechanics and overall entertainment value. Educators confirm that GlowMaster motivates students to strengthen their focus by advancing through progressively difficult game levels. Psychologists appreciate that GlowMaster enables students to gain an understanding of what focus feels like and what they need to do to activate that feeling. Teachers and parents are able to track student progress on a separate device. Most importantly, children who play through the entire game tell us that they are able to migrate the skills learned in the game to their everyday lives.

One Sentence Summary: GlowMaster is an engaging game that takes students on an experiential learning journey to master focus through play.

Main Text:

Introduction

We live in an age of distraction. Noisy environments. Intrusive distractions. Jam-packed calendars, for our children as well as ourselves. No wonder that students are struggling to stay focused on their studies and myriad other tasks. It is narrative often repeated by doctors, educators, and parents. And all too often, these stories are infused with blame, guilt, and anger. But the truth is, it's not easy to focus in today's demanding world. Focus is not a command that can simply be obeyed. It is not a topic that can be taught like geography or history. It is a skill that must be learned from experience.

Focus is an abstraction that is perceived differently by different people. Accordingly, GlowMaster enables students to learn and experience focus in their own way, at their own pace. Because GlowMaster has an appeal similar to other video games that students are currently playing, players are self-motivated to complete the game. Through this experiential play, students develop greater self-awareness and build better behavioral habits. By the time a student reaches the final level of GlowMaster, they are ready to apply their newly developed focus skills to their daily lives.

Background

It has long been established that children with attentional issues have different electroencephalogram (EEG) patterns from the normative population. Neurofeedback training (NFT) has been widely used with significant success for over forty years. The methodology is to present the subject with some form of visual, auditory or haptic feedback that is representative of their EEG state and provide an exercise that promotes a transition to a desired EEG state. It is considered to be an effective method for attention-related learning issues. However, due to significant drawbacks such as high cost, the inconvenience of clinical visits (if available at all), the discomfort of clinical EEG headsets, and a high dropout rate due to boredom within a session, psychologists are often reluctant to recommend it to students.

Recent technology innovations have enabled clinical quality results to be achievable through self-administered therapies at home or school. One game changer is the introduction of highly accurate, low cost consumer EEG headsets, such as the MindWave Mobile headset included with GlowMaster. These consumer headsets sufficiently meet the need for GlowMaster's application as well as being both convenient and affordable. Another game changer is the ubiquity of tablets and smartphones, and the ability to deliver compelling, high quality game play that is linked with these low cost EEG headsets.

The Game

GlowMaster is an action-adventure game that involves flying an airplane through a series of increasingly challenging missions. The airplane needs fuel to complete its missions, and that fuel is supplied by the player in the form of (high beta/low theta brainwave) focus. When the player is focused, the airplane glows. The higher the focus, the brighter the glow. With each successive level, the airplane needs more fuel for its increasingly challenging maneuvers, so the player is motivated to strengthen and extend their focus. Over time, players are able to activate focus when they need it – in the game, at school, on the field, or any time concentration is required.

From a gaming perspective, players are able to collect coins throughout their missions for customizing their airplane, buying additional resources to complete missions, and unlocking additional content. Game mini-maps guide players through the environment and positive reinforcement messages encourage the player whenever their "fuel"/focus levels get low. Every aspect of GlowMaster is designed to deliver a positive experience and make every player feel like a hero.

The "glow" is a mnemonic for focus that students take with them wherever they go and whenever additional concentration is required to complete a task. Upon completion, players become "glow masters."

The Playto Dashboard

The Playto Parent Dashboard is an integral part of the GlowMaster game. While the child plays the game and earns stars to unlock new levels, the dashboard shows parents their child's progress in building focusing, organizational, and memory skills. The dashboard also includes suggestions for simple ways that parents can reinforce their child's new good habits through motivating discussions and activities. This combination of the GlowMaster game and more mindful parenting interactions sets the stage for a child to make remarkable progress.

The Protocol

Consistent with research on the effectiveness of NFT, GlowMaster players achieve their best results after completing 50 half hour game sessions across two to three months. This is the recommended protocol to garner the maximum benefits of GlowMaster so that attaining the "glow" and the associated brain state becomes automatic for the player.

In each session, the player is required to exercise working memory skills, self-regulation, and focus visualization in order to complete GlowMaster missions. Individual game sessions shutdown after thirty minutes to help the parent and child manage their daily gaming and screen time. After the completion of each session, both game and EEG analytics are uploaded and then transformed into progress reports which can be accessed through a separate dashboard application.

The Results

Children between the ages of seven and thirteen who played through the GlowMaster game have reported numerous positive benefits. The children indicated a heightened awareness of their own focus and concentration levels and felt more confident in their ability to control it. Some children also improved in their ability to inhibit their impulses. Parents indicated that they saw improved academic results, attention and organization in their children.

About the Developer & Publisher

Playto Holdings Inc. is a developer of engaging video games that help children develop the basic skills required to succeed in all aspects of their lives. These foundational skills – such as focus, organization, and coping with anxiety – cannot easily be taught, but can be learned from experience. Playto builds these learning experiences into games that are fun to play and richly rewarding. GlowMaster is Playto's first release.

05.

Mob Scene Filter: Privacy Protection in Videos by Changing Facial Appearance

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Abstract:

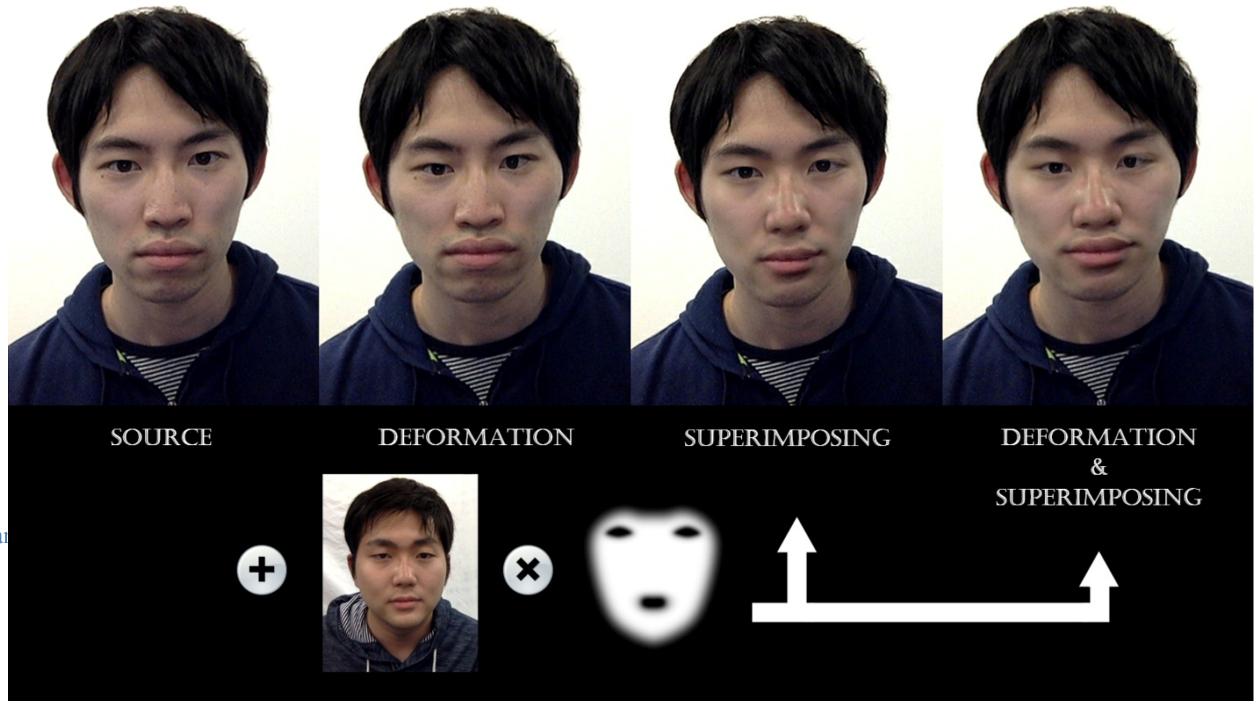
Mob Scene Filter (MSF) aims to prevent identification of an individual identity by changing one's facial appearance. Currently, image processing techniques, such as the mosaic and the blur, have been used to prevent identification of a person's identity. These techniques, however, make people difficult to understand the context of the video, because the facial expressions of the characters and the background in the video are masked. Thus, there is an inherent need for an advanced privacy protection technique that protects privacy but still maintains the context of the video. So, we focus on changing the facial appearance of characters in videos for protecting their privacy without compromising on the information from facial expressions. Then, we propose a system called MSF that changes not only the facial textures but also the arrangement of the facial regions and their size. The system first identifies a face and facial features in a video. Then, the system superimposes another person's face on those identified faces, and transforms the size of facial regions and the arrangement. Humans mainly use the arrangement of the facial regions to identify others, and so we modify the facial regions for altering face identification effectively.

One Sentence Summary:

This system aims to prevent identification of an individual identity by changing one's facial appearance with keeping facial expressions.

Introduction

Mob Scene Filter (MSF) aims to prevent identification of an individual identity by changing one's facial appearance.



gure 8: MSF cha
cial expressions.

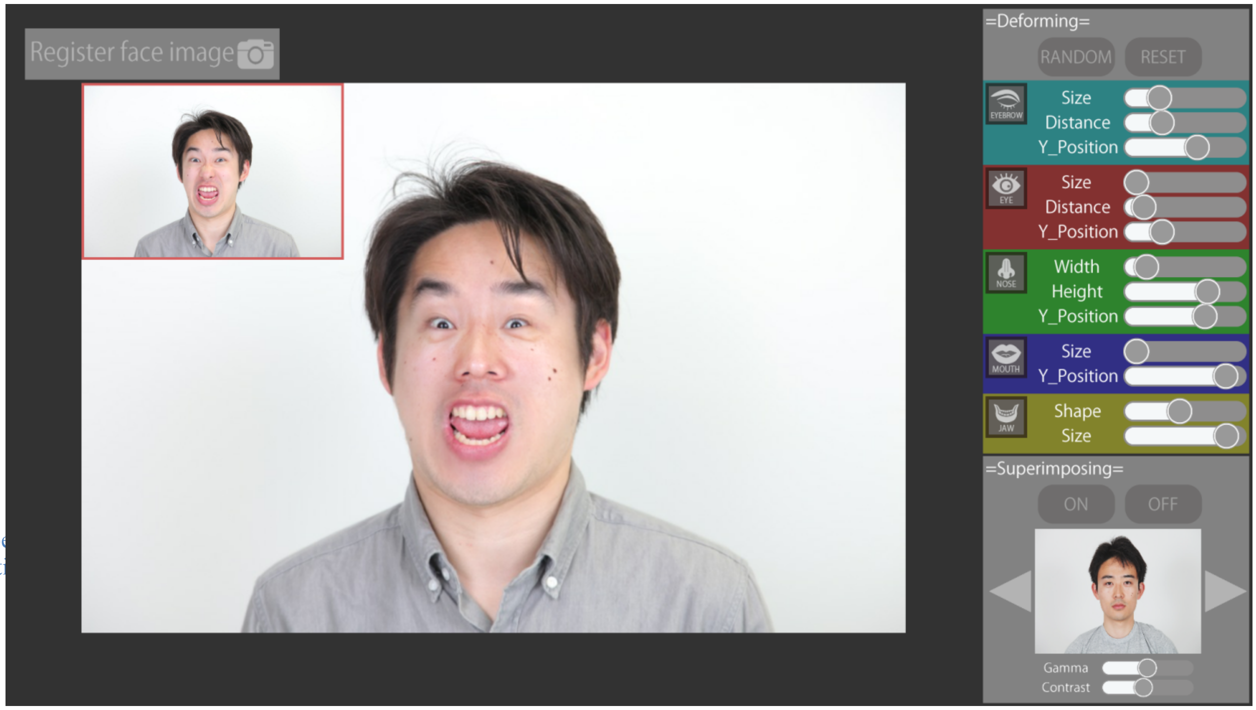
With latest technology, videos are becoming increasingly high-resolution, from high-definition to 4K/8K resolution. Moreover, with the development of image technology, every scene in a video is very clear enough to understand its details. Improvement of resolution, on the other hand, might accelerate privacy problems for videos used in TV broadcasting or when uploaded on the Internet. People can easily identify an individual, who is in a video, due to the high-resolution image quality.

Currently, image processing techniques, such as the mosaic and the blur, have been used to prevent identification of a person's identity. These techniques, however, make people difficult to understand the context of the video, because the facial expressions of the characters and the background in the video are masked. This detracts the benefit of the high resolution. Thus, there is an inherent need for an advanced privacy protection technique that protects privacy but still maintains the context of the video.

In this paper, we focus on changing the facial appearance of characters in videos for protecting their privacy without compromising on the information from facial expressions. Then, we propose a system called Mob Scene Filter (see Figure 1) that changes not only the facial textures but also the arrangement of the facial regions and their size.

Mob Scene Filter

MSF is composed of three major processes: 1) face detection and facial feature tracking, 2) superimposing another person's face on an individual's face, and 3) modifying one's facial regions. The system first identifies a face and facial features in a video. Then, the system superimposes



gure 9: MSF supe
ntification effecti

another person's face on those identified faces, and transforms the size of facial regions and the arrangement (see Figure 2). Humans mainly use the arrangement of the facial regions to identify others [1], and so we modify the facial regions for altering face identification effectively. This is the novelty of our research.

1) Face detection and facial feature tracking: Facial feature points of every person in the video are needed to manipulate facial characteristic. Thus, the system first identifies the approximate areas of the face of every person using the OpenCV Haar-like face detection technique. Then, the positions of facial regions are calculated by reference to those areas using Saragih's facial feature tracker [2].

2) Superimposing another person's face: We then transform a single face image for each person and superimpose the transformed face using Poisson Image Editing [3]. However, in order to reduce the unnaturalness of unmoving eyes and lips in the video, the areas of eyes and lips are not superimposed.

3) Modifying one's facial features: We then develop a method for transforming user's facial arrangement and size randomly using an image deformation technique [4]. By using this method, we additionally modify the face, which is already superimposed on another person's face, making it difficult to identify an individual in the video scene.

Conclusion

In this paper, we presented an enhanced privacy protection technique by altering faces in a video into another person's face using new techniques that will protect privacy but not compromise on the context of the video. We intend to develop non-linear video editing software for TV broadcasting using the knowledge gained through our new methodology, thereby improving the overall quality of the system.

This system could be applied to entertainment and educational technology as altering one's own perception by modifying his/her face. For example, we are planning to hold the workshop for elementary, junior high, and high school students to promote their greater understanding of basic science.

In IMMERSION 2015, we will demonstrate MSF in real time through a comparison of original videos and videos converted using MSF. Visitors will be able to experience the MSF technology using their own faces, and compare the effect of the MSF with existing ones.

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POSTERS

01.

Art in the New Digital Landscape

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New Technologies of Art/New Media Art of the Academy of Fine Arts in Naples is a 3 + 2-year bachelor course, established in 2008, which aims to provide training in the field of artistic research and offer innovative and original solutions relating to new technologies.

The course takes place not in the traditional classroom but in a laboratory which develops the academic life of both students and teachers. The practical workshop is directed at research, continually put into practice in the outside world through the development of projects in collaboration with other public and private institutions: Comune di Napoli (*City of Naples*), Napoli Teatro Festival (*Naples Theatre Festival*), Città della Scienza (*City of Science*), CNR-Consiglio Nazionale delle Ricerche (*National Council for Research*).

In this laboratory disciplines, teachers and students constantly mingle, blend and intersect, following the cultural model of the Web. The result is a combination of the differences of each in a collective intelligence targeted to construct "relational anthropological sculptures".

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Abstract: The “Festival del Bacio” is a site-specific “relational anthropological sculpture” based on the integration of visitors, technological installations and the Web, where people are fully involved and connected by means of aesthetic devices.

Each participant becomes the spontaneous and necessary element of a collective art work, contributing to transform it into a human and digital flux that flows into the Web.

The “site-specific” concept comes from the willingness of locals, shopkeepers, associations, passersby, tourists and others to form close relationships through which they become the active protagonists of a collective sculpture, not imposed from outside but coming from within each single person himself and from the environment in which the event takes place.

Depending on the amount of financial support received the lengthy process from conception to completion results in one or more days of celebration.

The technologies applied include interactive sound, video and photography, 3D, augmented reality and apps, all combining into the context of traditional folk festivals animated by bands, street art, happenings and street food.

For such events to succeed, lengthy preparation is necessary, from the graphic concept for the advertising campaign to the guerrilla marketing on the social networks.

***Art* as “*connective* aesthetic”. How to create a full immersive sensorial experience by fusing human aptitudes and new technologies.**

Introduction

The path of artistic education offered to the students of the school of New Technologies of Art develops through cognitive, participatory and relational processes and, especially, with an intense practice of immersive, intersecting and interactive technological experimentation (Figure 1. Brainstorming in the Lab). The cultural project that we propose here, new and alternative to the traditional art system, is based on the process of first dematerializing the original art work, then remodeling a new one in different forms, obtained by the meeting of the hyper textual ability of man’s thoughts with the hyper textual mechanisms of the Net.

Our idea is based on the observation that, unlike previous technologies, the computer is a 'prosthesis', a physical and virtual extension of the human brain, on which society is reformulating.
We have therefore initiated a discussion on contemporary art and what Nicolas Bourriaud [1] says on the effects of the information technology revolution that, as the French scholar claims, are not looked for in the artists who use computer technology as an ideological tool, limited to a functional and illustrative manipulation of fractals. Furthermore, we use the concepts of "collective intelligence" of the philosopher

Pierre Lévy and "connective intelligence" of the sociologist Derrick de Kerckhove, to support our procedure theoretically.

The result is a succession of links, mutual influences and connections where the ancient practice of citation, to which art had accustomed us, is replaced by the new *remix*. This allows us to build a mode of artistic expression capable of transferring traditional linguistic and conceptual rigors in an uninterrupted relational flow, open and constantly evolving (Figure 2. Interactive art installation Magnifica Astrazione).

In seven years of testing we have defined the mechanisms of a dynamic operating process able to trigger and enhance the size and quality of the artistic projects we carry out. The technique is that of exchange and interaction. We move increasingly toward the unstable boundary where there is an overlap between art and communication of art, between art and information on the art, and among art, practice, and the theory of making art.

The Process

The activities are created and developed through exchange, interaction and research. The errors incurred along the way are considered confirmation of aesthetic and poetic sense. The result is called "relational anthropological sculpture", and is determined by the development of a participatory flow and of interaction that breaks the limits of individual subjectivity to reshape practices and ways of creativity.

The cultural and aesthetic value of the finished products can only be found in the process that generated them: experimentation, sharing, interaction, intersection. Therefore, we work toward the completion of a collective and generative work of art in which the main principle, the subject not indifferent to the traditional art system, is nonexistent because it is precisely the absence of strong subjective or individual presences that dilutes it to the point of evaporation, making it superfluous and meaningless.

In addition, aesthetic devices designed to find their strength intangible and uncontrollable in the permanent interactive flow generated by technology, lose their value of "relic art", escaping in a natural way to the logic of the market. Of each sculpture, only the surplus value remains, invaluable and unique: an aesthetic and poetic device which, while maintaining the character of the ephemeral and fleeting, also has a digital heart and collective soul (Figure 3. Pixilated and pulsating heart on the Maritime Station of Naples).

We regard this approach as a new frontier of art, not only because it attempts to replace the concept of works of art as tangible objects with the idea that, rather, they are an impalpable exchange of emotions and human relationships, but also because it develops unusual processes of reflection regarding the continuity of relationships between the one and the many, changing the individual's way of thinking and even his social life. A method, however, which does not lose the specificity of the individual in a generic anonymity for it makes him functional in the construction of a practical and theoretical knowledge that determines the artistic operation itself.

The new artist is, therefore, complex, multiple, collective, or better still, 'connective', if we refer to the mechanisms that regulate the operation of the Web (Figure 4. Creating the immersive art installation Cuore Anima, 2013, Sorrento).

The Artist, the Art Form, the Public

The exchange of knowledge and the increasingly popular access to *open-source* heritage inevitably bring disinterest to the time-honoured theme of citation (with or without quotation marks) in favor of *the mash-up* and *remix*, which exclude positive attribution of authorship.

Today art takes on a bold new life through the interconnection of personal relationships whose aim is not only "relational art" as conceived in social networks and happenings, but also the use of the 'new' technologies, used not as pure *techné*, but as models of thought, borrowing the hyper textual modes of operation.

«Toute représentation peut faire l'objet d'échantillonnage, de mixage, de réemploi, etc. Selon la pragmatique de création et de communication en émergence, des distributions nomades d'informations fluctuent sur un immense plan sémiotique déterritorialisé. Il est donc naturel que l'effort créateur se déplace des messages pour aller vers les dispositifs, les processus, les langages, les « architectures » dynamiques, les milieux». [2]

In this new field of action the role of the public becomes fundamental and acquires a new function which increasingly coincides with the strength, prominence and meaning of the artist.
With the widespread aestheticization of the world and the disappearance of the author as an important reference for artistic production, it is now possible to analyze and look more serenely at an art form that places the subject in the background, diluting it in a plurality of individuals valued for their differences and specialism, who are asked to produce new languages (Figure 5. Insert Scorie, Interactive art installation, Special Haward at Premio Nazionale delle Arti 2010).

The subject, then, disappears and the "device" becomes the central theme. The device/art work creates actions, thoughts, connective currents that generate a dynamic participation fusing the artist and the audience, eliminating the objective role of the art form, transforming everything into a multisensory experience. Everything is projected into a technological environment through the flow of information, knowledge, promiscuity of knowledge that exist thanks to their connective and relational ability. Art, therefore, produces "a project of reconfiguration of collective behaviors and feelings" that is not technology but becomes technology, using "devices within a poetic and ethical project". [3]

The Modern Barbarians

With the inexorable force of anthropological necessity, modern βάρβαροι recognize, by practicing it, the multiplier mechanism of relations and bend it for artistic purposes. They plunder and prey on individual thoughts and loot them, contaminate them, disperse them, confuse them, join them with others who are distant and opposed. They tamper with classifications and categories, open the locked rooms of laboratories, "contaminate" the art with the experimental seed of science, but also with the everyday one of the road. Ideas are born from universal ambition, which arise more often from the emancipatory potential of error and contribution inherent in diversity than from rules and homologation. They chase intuition and ride life. They unhinge space and time. They are the optimistic and proactive response to the crisis.

The "resilient barbarians" are called to arms to write new languages. With a pop attitude they interrupt the recurrence of traditional patterns of thought to produce a generative flow of energy that results in new and multiple points of view and knowledge.

The resulting method is the creative flow that causes contamination between idea and process, between experimental research and theory, translating itself, through the relationship between the individual and others, into an artistic and cultural collective global experience. "Anthropological relational sculpture" means, therefore, an artistic proposal that is based on the connective and interpersonal relationships that spread a new aesthetic and artistic experience, which makes the individual the protagonist of the process, an integral part of it, but only because of his relationships with others (Figure 6. Tunnel of Munch art immersive installation).

This ensures the growth of the individual, empowered by a network of relationships in which the connections take rhizomatic shape and interchangeable functions similar to the model of the Net. This abnormal model of artistic creation, to which everyone has equal access, is based on the differences and peculiarities of each, on an "imperfect horizontality" that harmonizes the process of research and experimentation. Through the connection, the creative process that turns the mistake into an unexpected "value" (Media 1. www.mediaintegrati.it/files/ied.mp4).

The Trident

It begins in the laboratory, which by vocation opens outward, constantly looking for new contamination.

The mode of co-working in open space, also recently introduced in the Finnish educational system, facilitates the transmission of knowledge from teacher to student, from student to teacher and student to student. Furthermore, the use of *open source* or freeware programs such as Processing, Pure Data, OpenCv, Audacity joined with various free API (like Google V 3.0 and Instagram) and versatile hardware like Arduino, Kinect or Raspberry, allow free and creative experimentation in every field of the new technologies.

The laboratory is not just a physical area but extends continuously in space and time through the communication 2.0. Thus, students and professors build relations between daily courses (such as Digital Video, Web Design, Sound Design, Digital Photo, Multimedia Design, Design of interactive software) and research. Here the flow is generated by the logic of the "Trident": the laboratory of New Technologies of Art, didactics and company dimension (Figure 7. Classroom portrait).

The Laboratory of New Technologies of Art

Given the heterogeneity of the elements, the laboratory is attended by about 250 students and not structured on a precise model but changes and evolves, adapting to each new project, allowing the growth of the individual in the group through creative paths and brainstorming that lead to an idea and subsequently the completion of a work.

Starting with the creative phase, it works on connections, interaction and on the links that are generated between the various elements with the sole purpose of proposing new aggregating systems focused on the participation of the user. The technical aspect plays a fundamental role in the formation and is an exercise for the mind of the young artists: through practice, the concepts take on a physical form destined to evolve during the entire creative process.

The same form suggests new ways, and concepts will change along with the forms. The experimental approach to the matter finds unexpected, endless solutions and materials; techniques and tools become resources to circulate new schools of thought.

Didactics - *Mixed*

Mixed is the name of the group of twelve teachers that mixes with students of different years, sharing different forms of knowledge that, when combined, generate more and new knowledge. The specificity of the teachings is distributed through lessons consisting of, without distinction, both practical and theoretical subjects. The constant discussion topic, always linked to projects aimed at opportunities for external visibility, is the focal point of the entire experimentation, which tends to seek aesthetic solutions that do not follow the chimera of the "new", but the ethical consistency of aestheticization throughout the world.

The Company – *mediaintegrati*

mediantegrati is a team of artists trained at the School of New Technologies of Art at the Academy of Fine Arts in Naples.

After completing their studies, a group of former students founded a company. The territory in which it acts is that of the generative horizon, constantly evolving and, by definition, without boundaries.
mediantegrati is the operational arm of the school. It is the natural 'receptacle' containing the lab project and its physical expression outside, as well as the finalization of a long study process. [4]

Festival del Bacio

Festival del Bacio (*Kiss Festival),* now in its fourth edition, is one of the projects realized by the New Technologies of Art laboratory and arises from the consideration that the kiss is the most common form of non-verbal communication in the world: a simple gesture capable of encompassing a wide range of complex and sometimes discordant concepts but always inherent in the relationship. It is an opportunity for contact, sharing, but in particular it is an instant exchange of energy that can transform the souls of those involved, for whom nothing may ever be the same again. It is the ideal concept from which to build a common ground, creating virtuous exchange mechanisms that can undoubtedly modify the relationship of the individual with the community.

The Festival del Bacio aims to encourage the participation of public institutions and local communities at every stage of the project on the territory, which is why the format is different from traditional local festivals that do not activate relations with the parties involved.
Encounter, exchange, connection, common territory are the keywords of the project and a big red pixilated heart is the visual symbol that is placed in a particularly representative location of the city.
The public spaces chosen are identified by banners, posters, audio and video performances, acoustic and interactive installations, mapping and interaction devices on the Web, all triggered by the encounters between people (Figure 8. Touch and Wave interactive art installation).

The totality of these elements, seen as a whole, makes up the artistic experience we call "relational anthropological sculpture".

The Festival del Bacio adheres to the idea that art is really an open form, not open exclusively to possible interpretations but rather is created by the relationship between the city and its inhabitants, informed and part of a perpetual flux.

All the projects of New Technologies of Art and *mediantegrati*, including the Festival, contribute to the endangerment of the traditionally understood role of the artist, no longer the sole author of the work of art. The *master* and *artifex* artists are replaced by a mobile collective that collaborates with local communities, institutions and individuals to create the Festival.

The atelier, intended as a critical space of production, to which Daniel Buren in 1971 devoted an essay highlighting that the study encompassed the expositive moment in it, explodes in the artistic practice of New Technologies of Art and *mediantegrati*.

The production time is developed in the areas of didactic training and in the public space where the

Festival takes place. This public space, with its borders extended by cyber-space, is required to activate the relationship with people, the project's vital nourishment.

Like Pierre Levy, who in 1994 recognized in the open context of cyber-space a mode of communication that provides the possibility for everyone to communicate with everyone and constitute a common context participating in a universe of collective meanings, New Technologies of Art chose the permeable form of a fete, which lends itself as a territory of encounter and enjoyable exchange.

The analysis of each element that surrounds us is a fundamental part of our work. Each project is a fusion of different skills, equipment and people.

The initial relationship is established between the retailers and buyers and the role of the collective is to mediate between the various parties involved in the project. The artist becomes creative mediator by participating in the process. Through this collaboration, based on barter, the windows which are customized by the imagination of each retailer become replicators of the creative flux that the Festival sets in motion and interprets.

In their manifesto for the post-technological age, Andrea Balzola and Paolo Rosa wrote "Art is a process, not a result": the Festival del Bacio is a widespread and varied performance that through reciprocity and collaboration facilitates the process which determines the flow.

Aesthetic Devices Distributed to Businesses

- Cinemagraph: the reproduction of a static image with a detail in movement.
- Flip Clock: a symbolic element of the Festival del Bacio that produces rotating themed images.
- Augmented Reality Map: an interactive program in 3D allowing easy location of the strategic points of the festival.
- Scanimation: an aesthetic device of photographic animation.
- Shopper and gadget: replicate and transmit the symbol of the Festival.

Aggregating Interactive Devices Installed in Public Areas

- "Photon": ironic reference to the practice of street photographers depicting tourists near attractions. The bright devices allow more people to be photographed, entering into relation with each. Other (Table 1 www.mediaintegrati.it/files/fotone_blueprint.pdf).
- "Tunnel of Munch": LED-activated sound installation modulated by the intensity of the voice captured on a microphone.
- "Touch and wave", "Touch and pulsate", "Touch and illuminate", "Animaled": installations activated by contact between people and conductive plates which operate photographic, electrical and mechanical devices (Table 2 www.mediaintegrati.it/files/tocca_blueprint.pdf).

Connectivity Devices

"#cuoredinapoli": an instrument of recognition and integration (Figure 9. The hashtag #cuoredinapoli on a megascreen placed at the monumental Piazza Plebiscito, Naples).

The photographs, videos and tweets, posted with this hashtag on social networks by all users, are placed in real time on the Festival website, forming a big pixilated heart. [5]

Conclusions

The Festival del Bacio is a process that activates a relational device resulting from an operational mode providing integration of the didactic model of the Trident and artistic practice.
Through extensive use of the interactive and immersive installations described above it has been possible to increase the awareness of belonging to a common ground, both in the students' training process and through the enjoyment of the city's general public.

The aggregating device/work of the Festival, in its latest edition held in the historic center of Naples on March 28, 2015, involved 417 shops over a distance of three kilometers adorned with 100 banners and 223 posters. Forty thousand gadgets were distributed and ten cultural events animated public areas. Everything was accomplished in partnership with ten public institutions and the support of nine technical sponsors who offered funding and services.

The viral campaign, which lasted a week, received 170,000 profile views on the major social channels (Figure 10. Lighted heart at the Directional Center of Naples).

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[4] Further nformation on the works of art is available on the www.mediaintegrati.it website.

[5] available at http://www.mediaintegrati.it/cuoredinapoli/

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5


Insert_Scorie_v1.0

Figure 6

Figure 7

Figure 8

Figure 9


FESTIVAL DEL BACIO
#cuoredinapoli
D·O·M·D·FRANCISCO·DE·PAVLA·FERDINANDVS·I·EX·VOTO·A·MDCCCXVI
CHA RI TAS

Figure 10

02.

Title: An Innovative Approach to the History of Science on Unicam Earth Island

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Abstract:

Virtual worlds in education represent an innovative strategy that needs to be experienced in order to bring out the potential and future possibility for use. Virtual worlds are inhabited as an alternative experience to reality, a reality where the value of your presence may influence the efficacy of both education and teaching. These are the theories germane to the experience described in this article, which focuses on the use of virtual worlds for the development of scientific skill. This project develops the virtual Unicam Earth Island within the island, which is built on the server of the University of Camerino with Open Sim software. The involvement, immersion and collaboration are hallmarks of the experience, which develop via learning through doing, enabling students not only to benefit from the environment in an active way, but also to interact with it and build upon it. The project Unicam Earth Island is part of Annalisa Boniello's PhD regarding the teaching of Earth Sciences. Annalisa Boniello is at present, working on her PhD at the School of Science and Technology, Geology Division, University of Camerino, Italy.

One Sentence Summary: An innovative project for students of various age groups, which allows for the discovery of Galileo Galilei, via three different virtual environments.

Main Text:

Introduction

The VWs are social environments called 'Multi-User Virtual Environments' (MUVEs). By simulating, the real world users can live a full experience via the screen of a computer. Bartle [1] states that virtual worlds allow users to change the environment where they live the virtual experience. Users are represented by avatars and interact with others in real time. Sara de Freitas suggests that virtual worlds mean sharing, collaboration, user control, persistence and interactivity" [2]. These virtual environments have a social and constructivist approach where learning by doing and learning, located along with an authentic assessment, is done by simulating real-world settings. These aspects allow several possibilities for Science teachers to build scientific learning environments.

Some examples of educational uses were recently presented by many educators in Open Simulator Online conference 2015 (OOC, http://conference.opensimulator.org) and in the conference Virtual Worlds Best Practices in Education 2015 (VWBPE, http://vwbpe.org/). These conferences underline the interest for educational use of virtual worlds.

The project 'Unicam Earth Island'

The aim of the Unicam Earth Island project is to disseminate this approach in Italian schools and Universities regarding Geoscientific education. The project was shared with a web site (http://d7.unicam.it/unicamearthisland/), a Facebook group (Unicamearthisland) and Twitter (@Unicamisland). On Unicam Earth Island different teaching methods for Scientific Education such as IBSE (Inquiry Based Science Education), PBL (Problem-Based Learning), serious games and role-play games have been tested in order to innovate the traditional method of teaching in Italian schools. In this environment, an avatar lives an alternative reality, where the value attached to his presence may influence the effectiveness of learning [3]. In this perspective, the emotional involvement of the user in the virtual path can become the engine for an innovative and effective scientific learning experience. In literature already, many studies report experiences designed to study the effectiveness of virtual worlds in Science Education [4]. There are many ongoing research articles relating to the application of these virtual worlds in Geosciences, but information is rather limited regarding the application of this project in the Italian school system. This work is the final project of a Science teacher, Luigia Palumbo, who attended an online course in Unicam Earth Island (Fig. 1) on 'Virtual worlds in Science Education; the example of Unicam Earth Island'. The course was dedicated to Italian Science teachers [5] in order to spread an innovative strategy to improve the teaching of science.

Fig.1 – Unicam Earth island

Method

The project uses a virtual world, UnicamEarth Island (hosted by a server of the University of Camerino) created with the software Open Sim (www.opensimulator.org). To view and access the virtual world, users used the viewer Singularity (www.singularity.org), the same viewer for all users, in order to standardize the experience. This 3D learning environment allows the exploration, problem solving, role-play, learning by doing and serious game.

It defines as a game aimed at education or training, or gaming platforms through which one may learn in an interactive 3D environment. An environment where users make use of avatars which

are either in action or performing training. The teaching method is mainly socio-constructivist and is implemented through a learning set, with a student-centered approach.
In this scenario, the teacher has the role of builder of a learning environment, a coach, an expert and facilitator. The work is focused on Galileo Galilei, a figure that is outlined in an increasingly detailed way, as the environment unfolds. Inventions, astronomical discoveries and Galilei's life, present an opportunity for students to be active participants in the learning process as well as creators of their knowledge through various activities. The idea was born from a task that Annalisa Boniello, a teacher trainer, assigned to a group of teachers. Using this idea, Luigia Palumbo, a Science teacher at a Middle School, then decided to create Galilei's Open Study. This experiment had a non-traditional approach, as opposed to a historical one. Annalisa Boniello supported the activity of Luigia Palumbo in order to expand the learning path with two other learning environments each with different purposes, to create the overall experience. The aim of the learning path is as follows:

- Enhance student motivation due to the degree of involvement and level of entertainment afforded,
- Develop a challenge that increases as the game progresses,
- Promote discovery learning and research,
- Encourage active learning and problem solving skills,
- Enhance both digital and scientific competence in a simulated reality which would be difficult to observe live,
- To perform tasks in a virtual environment, enabling a genuine assessment by rubrics,
- Observe, model and interpret the most obvious celestial phenomena through observation of the sky both during the day and at night, also using planetary and/or computer simulations,
- Reconstruct the movements of the Earth on which both day and night depend as well as the changing seasons,
- Build three-dimensional models in connection with the historical evolution of astronomy.

The students, in order to experience the activities, must be in possession of the basic prerequisites such as knowledge of the Office package and in particular, Word and PowerPoint. It also requires the ability to search for information on the Web. No experience in virtual worlds is required, but the ability of orientation, which most pupils at the end of their time at Middle School have, is crucial.
The trial of Galileo Galilei began by completing a Google Drive questionnaire online, which served to reflect on how students are learning science now and to bring to the forefront, any expectations that they might have. Subsequently, the pupils were asked about their knowledge of virtual worlds and if they had, in some way, ever experienced them. All their answers were recorded on an online wall, called Padlet. The work on the virtual world was carried out in pairs and each pair were assigned a customized avatar. The island was divided into three different learning environments. The first one (Fig. 2), mainly informative, represented the Open Study of a scientist, in which one could see a rotating cube whose sides bore both the pictures of Galileo, Copernicus and Ptolemy and their publications.

Fig. 2 - First learning environment

The student's task was to find out, to which of the scientists the Open Study belonged. This was achieved by the students viewing six observation panels, each showing the instruments which had been invented by the scientists. On one of the six panels, there was an ‘odd one out’, something which had been invented by another scientist, not one of the aforementioned three. After discovering which of the inventions could actually be credited to Galilei, the students then chose a tool and searched for it on the Web, in order to find out information pertinent to how it was done and how it worked. The pupils then recreated the instrument that they had chosen. Another pair of pupils created two panels, which displayed the features of the instrument invented by Galileo Galilei and how it was built in the virtual world. The second virtual environment (Fig. 3), predominantly demonstrative, was built in order to show some of the most important astronomic discoveries of Galileo Galilei .

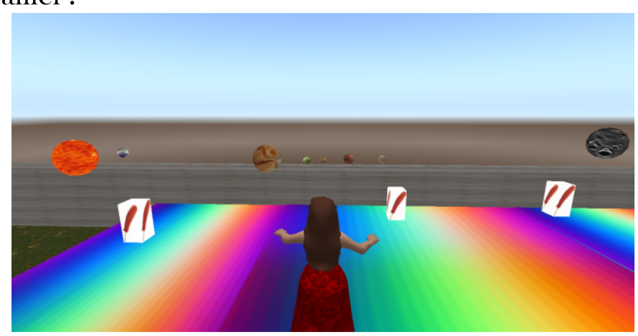

Fig. 3 – Second learning environment

One was able to gain access to the second environment via a suspended platform, from where one could see three constructions. The first one was the Earth turning around the Sun. The second one was Jupiter with its four medicean satellites, and the third one was the Moon. Each construction had a notecard with a questionnaire. The pupils were able to rebuild the discoveries of Galilei by answering the questionnaire. On the platform there was a panel showing the drawings of Galilei, the Sun and sunspots. The student’s task was to create the Sun according to the descriptions of Galilei. The third learning environment (Fig. 4), predominantly exploratory, was built to play a game, regarding the life of Galilei.

Fig. 4 – Third learning environment

Thirteen balls were hidden in a wood and each ball had a notecard describing a part of Galilei's life. On the notecard, were words, as well as dialogues, birth and death certificates, statements and letters. The game was played by two teams. Both teams found the balls and then put the clues in chronological order, thus reconstructing the life of Galileo Galilei. The last activity was the planning and implementation of a multimedia product regarding the life of Galilei. One team produced a video, which was uploaded to 'YouTube'
(http://www.youtube.com/watch?v=CD25HU0QEYg), while the other team created an interactive map in Popplet (http://popplet.com/app/#/2519561).
An online check was structured through Flipquiz (http://flipquiz.me/u/ginapalumbo/galileo-galilei) using five categories of questions, such as 'The Private Life of Galileo Galilei', 'The Theory and Astronomical Discoveries of Galileo Galilei', 'The Inventions of Galileo Galilei ", "Controversy and Accusations '. The quiz was carried out in the classroom, on the interactive whiteboard, with the help of flash cards using different scores ranging from 100 to 500 points.
The oral exam was structured as a game: the students sat in a circle and then the teacher threw a ball to a student who began to explain a small part of the life of Galilei, referring either to his private life, or to his discoveries, inventions and publications. After discussing their chosen point, the student gently threw the ball to another pupil who would continue the explanation but without referring to facts or episodes previously told by others. The ball could not be thrown to a student who had already participated. During this performance, the teacher noted on a survey form, the kind of intervention and its evaluation: correct; correct and essential; wrong. At the end of the game, they were given two cards reporting three levels of evaluation (full, partial or essential), one about digital and cross-cutting skills, the other about scientific skills. The students indicated the level of skills attained and the teacher gave the same assessment for each student. At the end, a final questionnaire was created in Google Drive in order to determine whether the experience had been effective and motivating or not. The global assessment was also determined (Fig.5, 6, 7).

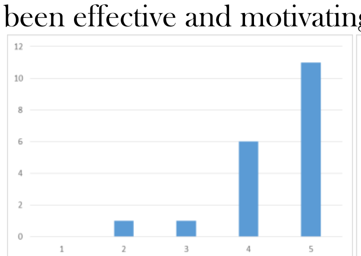
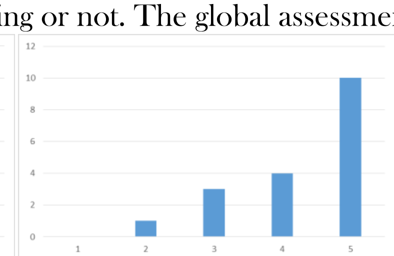
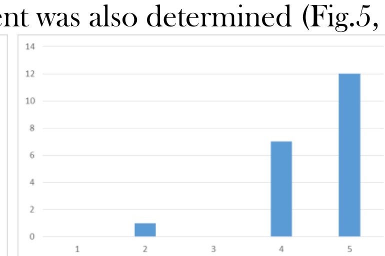

Fig. 5 – Motivating experience **Fig. 6 – Effective experience** **Fig. 7 – Global Assesment**

The scale of responses on the graphs are shown according to Likert (1, strongly disagree to 5, strongly agree) and on the ordinate, the number of answers. Data revealed that the experience improved motivation (60 % strongly agree, 32 % agree). It was effective for learning (50 % strongly agree, 30 % agree). It was very positively assessed globally (60 % strongly agree, 35 % agree).
Evaluations compiled by each student were compared to those compiled by the teacher and all discrepancies were discussed. In addition, student logbooks were read in order to understand their views regarding the experience and how they had felt during it. The experience characterized immersion, interaction and collaboration, and allowed the students to investigate a part of the history of Science, in an innovative way, achieving scientific, cross-cutting and digital skills along the way. Participating in groups represented by an avatar, allowed pupils to live a direct, personal experience within the environment, negotiating the Sun, planets and satellites - something that would obviously not be possible in real life.
The teaching approach was diversified according to the different environments, and structured mainly in paired activities, but also in large groups or even individually. This provided exciting

input which in turn, stimulated enthusiasm and the desire to live a completely different experience to that of all previous workshop activities. The fact that needs to be emphasized about this experiment is the reduction regarding the classical knowledge levels of meaning. All pupils can achieve a very high level of performance and evaluation. From a cognitive point of view, in the virtual world the worst pupils can be as good as the best pupils. The students engaged fully and demonstrated strong motivation and involvement. They were able to perform the same tasks in a precise and complete way and to become leaders within their groups.

Through virtual worlds, pupils explore an environment observing its characteristics and interpreting phenomena. The comparison with the teacher and discussion with peers, allows for the consolidation of all learned concepts and allows for any misconceptions to be overcome. Workgroups and game activities encourage learning in a situation where cooperation is crucial.

Motivation, fun and the enhancement of self-esteem, especially in children with learning disabilities, are extremely important for their active and productive collaboration and participation. The experimentation was a factor, which favored inclusion and allowed for different learning pathways, both for pupils with difficulties and for those without, who, on the contrary, mastered the topics covered, as well.

Crucial was the synergy among the teachers for not only the structuring of the environments and activities, but also regarding feedback and problem-solving regarding potential technical difficulties. The cooperation of teachers from different schools and the planning of schedule tasks for parallel classes in the same environment would be useful for future exploration, in order to reduce the time taken for the construction of the environment and promote interaction between classmates coming from different situations.

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WORKSHOPS

01.

Title: Storytelling Through Animation

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Abstract: This workshop will take participants from the creation of original storyboards and character creation through animating their stories to produce an animated short. The focus will be on representing cultures, traditions as well as innovations while being conscious not to fall into stereotypes. Participants will be introduced to the 12 principles of animation set forth by the early Disney animators (documented in the book *The Illusion of Life: Disney Animation*) as they learn how to apply those principles to create an engaging and empowering animated story.

One Sentence Summary: A workshop on Storytelling Through Animation with emphasis on cultural reference and representation.

02.

Title: The Process of Designing Immersive Spaces

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Abstract: Often times one of the most daunting tasks for museums, libraries, schools and companies is to create an interactive immersive environment, whether it be a simple interactive online gallery, VR game, augmented reality app or fully immersive online or dome experience. Many institutions and non-profits have great ideas and a lot of enthusiasm, but often find themselves a bit befuddled when it comes to the actual production process of manifesting their ideas. Often times it is due to the fact they have never had experience with producing such a project and are not acquainted with the vocabulary or collaborative process needed to make such a project into a reality. So where does one even start? During this hands-on workshop participants will be taken through the process of how to identify what themes, objects, assets as well as technologies will work based on target end user demographics. This workshop also covers various aspects for designers and educators to keep in mind when creating an interactive immersive experience including how to find artist/designers, software and platforms as well as how to campaign for administrative support and outside funding including grants and corporate gifts. Workshop participants will also receive advice on working with students when projects have real-world clients and deadlines. All of this while participants build their own micro immersive environment.

One Sentence Summary: A workshop on how to design immersive interactive environments.

HANDS-ON WORKSHOP : Google Cardboard

HANDS-ON WORKSHOP : Immersive Bent's Old Fort (Minecraft)

HANDS-ON WORKSHOP : Virtual Harlem

HANDS-ON WORKSHOP : Storytelling Through Animation

HANDS-ON WORKSHOP : The Process of Designing Immersive Spaces

FOCUS WORKSHOP: Copyright, Patents and Intellectual Property Rights in the Age of Immersion

FOCUS WORKSHOP: Digital Conservation in the Age of Immersion

See the complete descripion of workshops online at:

http://summit.ImmersiveEducation.org/sponsors_exhibitors.html

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