

Reimagining 21st Century Educational Connectivity through Fractal Imagery

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Abstract

Higher education institutions are facing increasing demands for providing alternative technology-based teacher preparation programs that would more closely service the needs of the ever-changing 21st century populations. In today's amalgam of cultural differences, education that is independent of biases is more than difficult to author. I propose using fractals that are never-ending patterns that change as you explore deeper into the fractal as another. Exploring the Mandelbrot fractal is computationally expensive as each pixel (dot on the screen must iterate through thousands of calculations to determine its appearance in the viable part of the fractal, only now are computers able to do this reasonably fast. My pilot study will explore ways for higher education institutions to build pedagogical fractal imagery content to foster more immersive learning, as well as, content that which mirrors the new mission of Shepherd University's School of Education: "Innovation, Experience, Empowerment, Vision and Collaboration".

1. Introduction

Exploring the fractal space is akin to a journey through an art wonderland. In recent years, the advance and spread of technology has been blamed for a multitude of problems, including social isolation, increased violence, short attention spans, and more. Now, educational counselors and therapists are putting the technology of virtual reality therapy to use helping their clients overcome fear, anxiety, anger and cultural unacceptance.

I will turn my focus now to fractals and working on developing an educational platform to allow individuals to explore the Mandelbrot fractal and allow users to merge places they visit with photographs or digitalized art using techniques popularized by deep neural networks to produce new art that represents a cultural and emotional journey of the person exploring the space [8].

This imagery experience should reflect the student's individual creative and/or critical thinking endeavors spanning the scope of their baccalaureate

studies which mirrors the new mission of Shepherd University's School of Education: "**Innovation, Experience, Empowerment, Vision and Collaboration**".

In recent years, the advance and spread of technology has been blamed for a multitude of problems, including social isolation. Now, therapists such as Thomas [12] are putting the technology of VR and fractal imagery/ art therapy to helping their clients overcome fear, anxiety, pain, phobias and PTSD." According to the U.S. Department of Education (2017), today's average student is no longer the 18-year-old whose parents drive them to the campus. Instead, the "new normal" student may be a 24-year-old returning veteran, a 40-year-old single mother, a part-time student juggling work and college, or the first-generation college student athlete. The faces we picture as our college hopefuls can't be limited by race, age, income, zip code, disability, or any other factor.

For higher education to fulfill its promise as a great equalizer, we need continued innovation that can move us toward increased access, affordability and equity for all who choose education as a career. This innovation will develop an ecosystem that will include a range of opportunities for a variety of high-quality educational experiences and credentials with marketplace value suited for the differing needs of students [9].

Computer Science as a field of research continues to change and evolve at lightning speed. Artificial Intelligence (AI) is reaching a breaking point where its applicability is being realized. There is a growing expectation that AI will play a much larger role in how we teach our students, but no one really knows where it will lead us. Another paradigm changing technology coming to maturation is Virtual (VR) and Augmented Reality (AR) [8].

Virtual and Augmented Reality are now a very affordable and viable option for most people to own at home. These have long been an abstract idea, mostly seen in futuristic scenes in the movies (Star Trek, etc.) until recently. The possibilities are endless, and it is natural to expect our computer science teachers to be leading the charge in

implementing these new, jaw dropping techniques such as our fractal imagery. These concepts will become normalized.

It is nearly impossible to explore any corner of social media and not discover elements of criticism about the Millennial Generation, often unfairly; coupled with very little consideration regarding what makes them exceptional. Critics of Millennials need to begin thinking about creating new pathways to communicate with and teach the newest generation of learners who will become tomorrow's community leaders. It is essential that the schools of higher education begin to disrupt the Industrial Age model for learning and move forward with progressive strategies to meet the needs of the Millennial education consumer; the "Net" Generation. This new generation of learners has a different way of demonstrating mastery than the learners of the past. The 21st century learner responds to instructional opportunities at a far more rapid speed than generations past and progressive educators have learned to make the most of the talents, skills and interests of today's learner in both real world and virtual educational settings.

2. Best Practices in Higher Education

To meet the needs of a rapidly changing and growing global economy, schools of higher education must pursue adoption of a global business perspective to be able to teach marketable 21st century skillsets. Institutions need to focus on shifting from the concept of a local economy to a global economy; a cultural disruption of traditional "Industrial Age" pedagogy for teaching and learning. They must respond to the radical changes introduced in the 21st century workplace to meet the needs of the complex world economy. Schools must shift from the old model of learning where teachers would broadcast information and shift to new instructional models for virtual reality, virtual learning, and interactive real-world situations in a safe online environment. The Net Generation learner is shifting from being a recipient of instruction to a learner focused on collaboration, interactive learning, and reflective research, practice and work.

According to the National Conference of State Legislatures (NCSL), there are at least five states that are requiring an online or virtual reality/virtual class as a high school graduation requirement (2017). Schools need to move from the one room schoolhouse way of thinking to successfully meet the needs of the Net Generation learner; from the teacher as a "sage on the stage" to a teacher who is "a guide or facilitator on the side". Institutions of higher learning need to think about individualized and collaborative methods for focused online and technological virtual learning experiences based on the needs of the individual, in a reflective and supportive learning environment.

Learning in virtual environments provides an opportunity for student-centered individualization of instruction; to provide opportunities to learn about tough and challenging situations in a safe and controlled environment [8].

2.1. Interactive Presence

Virtual Reality experience can be one of two things, or a mix of both. In the most passive sense, VR can be a medium to watch a 3-D movie in which a person can be standing in the middle of the scene and focus on an emotion without user engagement. This is accomplished by placing a 360-degree camera in the middle of a scene and recording the video information. On the other end of the spectrum, there are simulated environments where the VR user can move around, explore and interact with the items in the scene.

2.2. Culturally Unbiased Delivery

When we talk about the dynamics of creating a culturally inclusive online classroom community, the typical focus is on the diversity of the students in brick and mortar school building. All too often the culture and diversity of the adults are on the periphery. But to navigate the intersection of student and adult cultural diversity, we must first acknowledge and understand our adult beliefs and practices.

This thinking requires educators to be willing to explore and analyze our own history and its effects on our behavior. First, we must consider our historical and current living situations and conditions. When we examine our childhood, young adult, and present-day lives, we examine how our experiences influence us today and how they might influence our work with children and families who have vastly different experiences. While culture refers to a collective worldview, schools as culturally inclusive communities must relate to individual students first in addressing the distinct needs of the students who make up those communities, including the online virtual world.

Freire [5] addressed a critical concern on the "purpose of education" -- to develop individual thinkers who can provide innovative solutions to our complex problems. When we see education only to impart socialization and indoctrination, we do a great disservice to the liberating aspects that education can provide. Instructors of higher learning must start changing how they view their students-- they are complex beings with past experiences and thoughts that cannot be ignored [1]. To teach to a diverse group of students, an instructor needs to make the learning complex and malleable which mirrors how the brain works.

Some characteristics of the individual learner:

- Relies on the teacher to carry some of the cognitive load temporarily
- Utilizes strategies and processes for tackling a new task
- Regularly attempts new tasks without scaffolds
- Has cognitive strategies for getting unstuck
- Has learned how to retrieve information from long-term memory

Neurosciences will continue to highlight the tangible nature of learning, but the model of one size-fits-all is not conducive to real education [2]. While virtual delivery is often more convenient, not being able to see the learners and gauge their level of understanding and engagement can be difficult as a facilitator. One learns both inside and outside of the classroom; given the removal of the traditional interactive approach within online education, how can an instructor bring the outside world into the classroom? Highlighted below are some suggestions that could enhance culturally responsive and meaningful learning between the teacher and the student.

- **Awareness:** The instructor should recognize cultural norms of individualism as well as collectivism. Online instructors should acknowledge the socio-political context around race and language.
- **Learning Partnerships:** Reimagine the student-teacher relationship as a partnership and attempt to balance giving students both care and push. Cultivate a positive mindset amongst your students along with a sense of self-efficacy.
- **Information Processing:** Stimulate higher order thinking, instructional designers can help you match higher order objectives with the assignments and assessments that you as the instructor are planning on giving. Scaffolding becomes a component that can assist in the creation of independent learners in your online class.
- **Community of Learners:** Just because the instructor does not view the students face-to-face, does not mean a community of learning cannot be established. In fact, allowing students to have a voice by incorporating collaborative assignments, or allowing the students to help create the semester syllabus are great examples of building a community. A quality learning environment is one where the professor and the students both feel empowered to create their learning path. Building rituals and routines within the online course can also solidify the creation of a learning community. Creating a culturally

responsive online classroom does not mean catering to any one group, rather it involves being more purposeful with how and what you utilize to measure learning within the course. Instructional designers can assist in the creation of quality assessments as well as how to nurture a learning community [6].

Since the beginning of time, most new and emerging technology has nurtured an unhealthy attachment to acronyms and virtual reality is no different. What does it mean to be “immersed”? It is a term emerging into almost every industry, as organizations seek a spot in the modern consumer’s content-rich diet. There are increasing levels of immersion that technology can help us imitate, but true immersion is a relative concept [2].

3. Methods & Materials

While there are many sources of VR educational content available, the magnitude of work involved in taking our VR fractal imagery content even close to 100% for educators is staggering. I propose an idea with the potential to expand VR educational content and the quality of that content. I believe that with the distributed/cloud-sourced approach, embracing at least the idea of my proposal could change everything for higher education faculty and students. Before talking about system requirements however, let us talk about what educators would need to build quality VR content to facilitate their classes.

3.1. Educator Requirements

Two-dimensional (2D) and three-dimensional (3D) graphics (this includes user interface elements and image textures) and models for illustrations.

A method for the teacher to be able to make the VR demonstrations/lectures available to the students.

A set of tools to evaluate student performances for the VR lectures (VRL).

A very simple mechanism to animate the 2D and 3D resources. This would have to be setup in a very intuitive and easy to use graphic environment. An easy way to include group VR participation in VR demonstrations/lectures is through fractal imagery. Again, we can take advantage of AI to help the developer out, but we should also be able to make a very simple and straightforward.

A way of recording students’ interactions in the VR content. When learning modules are engaged by the learner, we need to be able to record and analyze the outcome to gauge progress and how well the student is learning the material.

An easy way to add “Text and Sounds” to any of the VR demonstrations/lectures. I would expect this to be offered in the form of a toolbox with these

options that is always shown to the content developer, but a pilot study and survey may find a better, more intuitive way of offering these features to the educator.

4. Research & Discussions

4.1. What Are Fractals?

Fractals are objects with irregular curves or shapes and are recognizable building blocks of nature. Trees, clouds, rivers, galaxies, lungs and neurons are fractals. The new discovery is not about improving inkblots for psychological assessments -- their use became controversial and mostly set aside in the last 20 years for the technologies emerging. It does, however, have implications for Taylor's efforts to design a fractal-based healing therapy [10]. "These optical illusions seen in art are important for understanding the human visual system," said Taylor, who is director of the UO Materials Science Institute. One learns important things from when our eyes get fooled. Whether such perceptions speak to mental health, reflect a person's level of creativity in education or simply draw from a person's past experiences for healing has been debatable. The United Kingdom is leading in the VR industry with new and interesting technology including a home for these ideas – a place where these thoughts come together and push forward the best and brightest working in Immersive Reality [4].

4.2. Medical Benefits

Medical application trainings of virtual reality are rapidly growing and for many obvious reasons. It allows people to be trained without harming others and doctors can practice their skills without touching a real human body. No one wants to be "the guinea" and operated on by a junior doctor. Additionally, this process helps to address issues before they arise.

One new VR surgical tool is Laduma [4]. The company is an immersive consultancy which has been working to create a new 360 experience of a S-ICD procedure, normally performed on people at risk of a cardiac arrest. The experience allows doctors to get a view of the process, next to a doctor in an operation room. These immersive qualities help to improve training in virtual reality without a tool being picked up. While expensive, experiences like these help doctors hone their craft and learn, without being in the operation room. Hands-on experiences will always trump other forms of training – yet it provides a great groundwork to build on [4].

4.3. Meaningful Learning Realities without Bias

There are multiple experiences which help people learn in virtual reality without bias. Companies tackle racial bias in numerous training programmers such as Starbucks in 2018, who shut 8,000 of its stores for bias training. Leaders should delicately handle these types of situations to educate their employees in the best way possible. These learning experiences have an adverse effect on the mental health of employees who work in the company.

Dorvilas [3] designed a VR experience to remove the shame and guilt felt afterward, via debiasing techniques. 'Companies can spend millions of dollars on extremely ineffective, and virtually useless training that can have an adverse effect which can hurt the company even more,' she said. "Bias training shouldn't be there to shame. People should feel good about making others feel accepted. Debias isn't something that you can work out in a day. It's a behavior that you must work through. We want to give people the capacity to work in a safe and comfortable space.' [3].

Dorvilas [3] found that empathy allowed people to humanize each other and applied that to VR. Numerous studies show that unconscious bias impacts education and teaching, as it shapes how people teach and how they see relative achievement. This shaped the creation of Teacher's Lens, an app which provides simulations in VR and reduces bias in a safe and comfortable way. The app presents the teacher with a racially diverse classroom, and tracks who the teacher interacts with. In this way, the benefits of virtual reality are made clear.

5. Conclusion

Thinking about my own teaching as a higher education professor and director of a school, leads me to wonder why most educators do not talk about the process by which we leverage understanding in one context to solve problems in other contexts. Why not be more explicit with teaching students about the skills and experiences required to transfer knowledge gained and heal cultural misunderstandings using fractal imagery?

5.1. Krathwohl's (1964/2011) taxonomy of the affective domain that I found easy to understand:

Receiving – Willingness to pay attention to an idea

Responding – Willingness to react to the idea in some way

Valuing – Willingness to be perceived by others as valuing the idea to some extent

Organizing – Incorporating the value of the idea meaningfully into an existing value system

Characterizing – Acting consistently with the now-internalized value. If you buy into the idea that the affective domain is an integral part of learning, then think it would follow (such as a fractal image) that students would need to be able to share the collaborative work they do. For students to be willing to be perceived as “valuing the study” of a topic, it must be possible for them experience it. This provides a rationale for expanding social media via the broader community. “21st Century learning facilitates the emergence of new approaches to learning that draw upon a range of insights into the human brain, the functioning of human societies and learning as a community-wide effort” [11], [7].

6. References

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