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Shaping the Futures of Learning in the Digital Age

Spatial Computing: Creating the Future of Learning

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Abstract: Spatial computing is the fourth paradigm of the digital revolution and could profoundly transform learning. It is the convergence of several technological developments, including Augmented and Virtual Reality (XR), Artificial Intelligence, haptic feedback, motion-capture, and situational awareness engines. This article explores how the shift from 2D screens to virtual worlds will impact learning and raise new ethical and digital literacy challenges. Spatial computing goes far beyond the simple use of a VR headset for virtual experiences. Microsoft's experimental Dreamwalker project has already demonstrated how a user can remain entirely immersed in a virtual environment while successfully navigating the real world around them. These developments offer far-reaching implications for learning and our social interactions. Students may prefer virtual embodied avatars who are adaptive, personalized, and available anytime over real faculty - or they may gain a new-found appreciation for human connection. In a world where the virtual and real converge, learning will no longer be limited to education organizations but will be embedded throughout human experience. When we are no longer confined by physical reality but by the worlds we can imagine, the ability to ask the right questions will be more critical than having the correct answers. With spatial computing, technology will no longer be an educational tool, but a platform for human experience.

Keywords: *Spatial Computing, XR, Virtual Reality, Augmented Reality, Immersive Learning*

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Spatial Computing: Creating the Future of Learning

If you cut open the present, the future bleeds out.
- William Burroughs

The More Things Change . . .

Higher education has been through waves of technological change, which seems to change everything and nothing at all. From early mainframes that took the space of entire rooms, we've moved to desktops and laptops, and mobile devices that put the mainframe in our pockets. It's transformed institutional operations, the student experience, and in some remarkable examples, the learning environment itself.

But for all the developments, innovation remains elusive. One can all too easily step into a classroom in higher education and find that little has changed. The faculty is in the front of the room, seated students dutifully (or not) take notes, and they are evaluated in ways they will seldom experience in the real world. Except in certain professions, most students will never take another exam after they leave college. Or ever write another paper with proper APA citations. As Ken Robinson said in his popular TED Talk, *Do Schools Kill Creativity?*, it's as if the primary goal of higher education is to perpetuate itself, to produce new university professors (Robinson, 2006). That's essential, of course, as no organization survives without ensuring its future. But the vast majority of our students will leave the university for the real world, unprepared for the challenges they will face.

The Next Paradigm Shift

Now that we're finally comfortable with mobile computing, we face the next wave of the Digital Revolution. Spatial computing or XR (it's too new to settle on terminology) is building like a tsunami on the horizon. This fourth paradigm shift of the digital revolution is a convergence of several technological developments, including VR, AR, Mixed Reality, AI, computer vision, sensors, haptics, and situational awareness engines.

Every previous development made our devices smaller, convenient, and more powerful. But while our digital content improved in quality, it has remained confined to 2D screens. With spatial computing, we move into a new realm of virtual environments. Technology will no longer be a tool to solve a task but a platform for human experience.

That profoundly challenges the current state of higher education. We're comfortable with our digital tools (even if we adopt them unevenly). We are even more comfortable in our debates about our digital tools as it avoids the risk of implementation. But spatial computing is not just another development we can shoehorn into our toolbox of Ed Tech solutions. When faculty and higher education institutions struggle with how immersive experiences fit into current practices, that misses the point. Spatial computing will challenge and undermine current practices.

Currently, immersive learning has found a home in engineering and healthcare education. But these are areas where simulations have long been part of the learning environment. The challenging move is when these developments are integrated into the social sciences and liberal arts. This is where spatial computing opens an exciting new realm of creativity through immersive storytelling.

Of course, our initial forays into spatial computing are rudimentary at best. AI is still in its infancy, VR and Mixed Reality headsets are bulky and uncomfortable. And all of it is cost-prohibitive. Technology always evolves this way. The first IBM PC (blazingly fast at 4.77MHz) cost the equivalent of $5,000 today. The inflation-adjusted price for the groundbreaking Apple Lisa? Over $25,000 today. But focusing on the cost and quality of the current state of the technology is just a reassuring narrative, a way to avoid addressing the challenges of the future.

DreamWalker: A Spatial Computing Example

Struggling to understand a future that we only glimpse through a distant haze, an example helps. Microsoft recently announced its DreamWalker project, an arrangement of sensors, cameras, and a VR headset that would let you navigate the real world while completely immersed in virtual reality. Relying on our current technology, it is bulky and ridiculous looking. No one would wear this today except as an experiment. But look at it as a glimpse of the future world in which higher education will exist. Here, the present is cut open, and the future bleeds out. A future where the very fabric of reality is no longer made of atoms but of photons that will bring human experience to almost magical realms of imagination.

Figure I. Microsoft's Dreamwalker Project

From the Microsoft Research Blog (2019):

> . . DreamWalker monitors users' environments using a variety of sensing technology—inside-out tracking via a Windows Mixed Reality-provided relative position trace, a dual-band GPS sensor, and two RGB depth cameras—to detect obstacles discovered along the way.
>
> Discovered obstacles that may move or appear in users' paths are managed by introducing moving virtual obstacles, or characters, such as pedestrians walking near users, to block them from any potential danger. Other options for controlling users' paths may include pets and dynamic events such as vehicles being parked, moving carts and more, limited only by the imagination of the experience creator. The real-time environment

> detection technology provides guidance for the creation of this additional virtual content with great care taken to generate these virtual obstacles outside users' field of view to avoid any unnatural "popping up" of objects in the virtual world.

It's a remarkable project, almost like a real-life version of what was envisioned in the movie, *The Matrix*. You can walk around the world and simultaneously experience another (virtual) world entirely. You might question why someone would even want to do this - we can discuss as soon as you remove the earbuds from your ears. We already exist in immersive environments of our own creation.

Spatial Computing and Learning

The opportunities and challenges in these developments for higher education are profound. In a spatial computing environment, any surface could become a virtual stage for embodied experiences that fuses gaze, touch, smell, and transcends human experience as we know it. Information and insights from people who passed through the space before you would still be accessible. You might even want to walk back their analysis to understand how they developed their conclusions. Virtual time and space will allow for past, present, and future to co-exist—a world where you can be anything and meet anybody.

Keeping students on task - already challenging in a world of ubiquitous social media - will become a pervasive environmental challenge. With spatial computing, students could be anywhere and yet experience anything they want. Our current innovative learning spaces have long renounced the chairs bolted to the floor of 19th-century education, but they still focus students' attention under the guise of flexibility. In the future, perhaps our physical campus spaces will be replaced by virtual portals to guide students' learning through challenges, collaboration, or mindful contemplation.

Spatial computing promises to finally personalize learning to the needs of each student. Virtual mentors will not simply offer directions and manage searches but drive our ability to learn. Objects in a room might even register and respond to levels of anxiety or confidence, sharing just the right amount of information students need. Learning becomes less about what you know and more about what you create with what you know. Imagination becomes the final frontier.

The Ethical Challenges

Spatial computing will raise profound ethical challenges and go to the very core of our relationship with the world around us. How do we determine the validity of our experiences when the boundary between the real and the virtual disappears? We spend a good deal of energy focusing on digital literacy and skills, but our definitions are based on the world we were educated in - a text-based world. Our students will live in a world radically different from the one we know.

In the social realm, an example can be found in Georgia Tech's mixing virtual teaching assistants in with their "live" TA's. But it will advance far beyond these early experiments. What happens when I can leave a virtual environment but my AI-driven avatar remains? What happens when faculty and students have digital twins - existing both as real and digital selves? Will students prefer the digital version of their faculty who are always available 24/7? Can our social fabric survive when our identities become completely malleable?

The questions here go far beyond the future of higher education. It's actually about our future as human beings. As the virtual world becomes more powerful and ubiquitous, what happens to reality? Will we leave it behind for our illusions or come back to it with a newfound appreciation for human connection? The very nature of the world will no longer be confined by

physical reality but by the worlds we can imagine. We will exist in multiple futures where asking the right questions will be more important than having answers. In a world of convergence where technology blurs the lines between the virtual and physical and AI avatars co-exist alongside us, learning will no longer be confined to education systems as we know them today - it becomes the very essence of the human experience.

The founding editor of *Wired Magazine*, Kevin Kelly, has argued that only through artificial intelligence will we come to know ourselves as human beings (Kelly, 2017). In the same way, spatial computing may present us with an opportunity to not just remake the world but reimagine every facet of humanity.

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