Leveraging Augmented Reality (AR) to Enhance STEM Education and Career Awareness

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Introduction

In the post-pandemic era, there is an urgent need to rethink STEM (Science, Technology, Engineering and Mathematics) education, especially for rural and underserved students. Augmented Reality (AR) is emerging as a transformative tool that can bridge learning gaps and make complex STEM concepts more accessible and engaging for students. C2C Policy Fellow, Michael Wilczek, explores how AR can enhance STEM learning and raise awareness of career opportunities, particularly in rural areas like Maine, where access to technology and STEM careers is limited.

Key Problem

The COVID-19 pandemic has deepened learning disparities, particularly in rural and underserved regions. In Maine, test scores in science are well below national averages, with underserved students, such as those with disabilities and from low-income backgrounds, being disproportionately affected.[1] A significant barrier is the lack of engaging and innovative STEM education tools in these areas. A recent study suggests that using these tools can excite and engage students, offering them insights into STEM careers while evoking interest.[2]

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[1] Maine Department of Education, ESSA Dashboard, accessed August 4, 2023, https://www.maine.gov/doe/dashboard.

[2] Hsu, Yi-Shao, Yuh-Herng Lin, and Bi-Yu Yang. "Impact of Augmented Reality Lessons on Students' STEM Interest." *Research and Practice in Technology Enhanced Learning* 12, no. 2 (2017). https://doi.org/10.1186/s41039-016-0039-z.

Augmented Reality: A Solution for STEM Engagement

Augmented Reality (AR) offers an immersive, interactive way to teach STEM concepts that are difficult to visualize in traditional classroom settings.[3] By integrating AR tools like the Microsoft HoloLens, students can visualize complex biological processes, manipulate 3D models, and collaborate with peers in a shared digital environment.
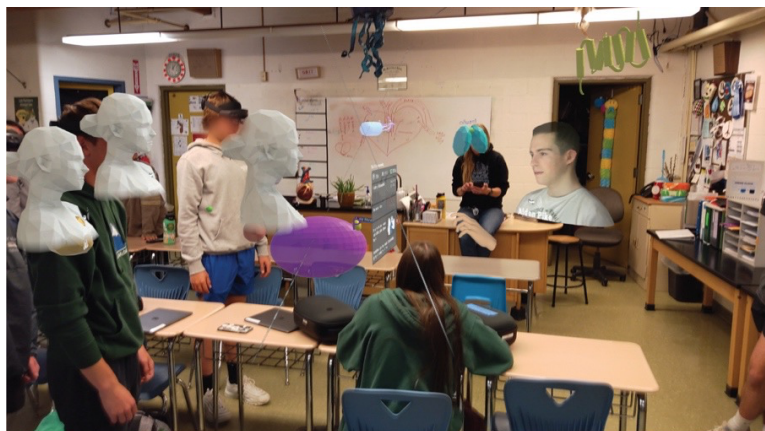
Aiden Pike, a bioinformatics program graduate, provides a virtual lesson at Mt. Abrams High School, a rural school in Western Maine.

Enhancing STEM Learning

Preliminary data from pilot AR projects demonstrate the potential of AR to improve student understanding of STEM tools and concepts. Students participating in AR-based learning in rural Maine reported a 50% increase in their ability to describe standard STEM tools. Furthermore, AR activities have been shown to increase students' knowledge of STEM career opportunities, although their direct influence on career decision-making is less pronounced.

Rethinking STEM Education Post-Pandemic

The need for new approaches in STEM education is clear. The pandemic has highlighted the importance of adaptive and engaging teaching methods. AR can offer:

- **Improved Understanding of Complex Concepts:** By allowing students to interact with 3D models and experience simulations, AR provides a multisensory learning environment that makes abstract STEM topics more tangible and relatable.[4]

- **Collaborative Learning:** AR technologies like HoloLens and computer software like Fracture Reality's JoinXR, enable students to work collaboratively in virtual environments, fostering teamwork and problem-solving skills crucial not only for STEM careers but for overall personal and professional development.[5]

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[3] Sahin, Didem, and Rukiye Muge Yilmaz. "The Effect of Augmented Reality Technology on Middle School Students' Achievements and Attitudes towards Science Education." *Computers & Education* 144 (2020): 103710. https://doi.org/10.1016/j.compedu.2019.103710.

[4] Sahin, Didem, and Rukiye Muge Yilmaz. "The Effect of Augmented Reality Technology on Middle School Students' Achievements and Attitudes towards Science Education." *Computers & Education* 144 (2020): 103710. https://doi.org/10.1016/j.compedu.2019.103710

[5] Garzón, Jorge, Kinshuk, Silvia Baldiris, Juan Gutiérrez, and Jesús Pavón. "How Do Pedagogical Approaches Affect the Impact of Augmented Reality on Education? A Meta-Analysis and Research Synthesis." *Educational Research Review* 31 (2020): 100334. https://doi.org/10.1016/j.edurev.2020.100334; Merriënboer, Jeroen J. G.

- **Diminishing Barriers to STEM Access:** AR technology can make STEM learning more inclusive by addressing challenges faced by diverse learners, including those with learning differences.[6] By creating an engaging, immersive environment, AR can cater to various learning styles and needs, ensuring that STEM education becomes more accessible and equitable across different student populations.

Leveraging AR for Career Awareness

In addition to improving classroom learning, AR can help raise awareness of STEM career opportunities. Collaborations with organizations like JMG (Jobs for Maine Graduates) will provide Extended Learning Opportunities (ELOs), enabling students to utilize Augmented Reality for real-world problem-solving, solution visualization, and 3D modeling while exploring new career pathways. This hands-on approach helps students see the relevance of STEM to their future careers.

Breaking Down Geographic Barriers

One of the most critical aspects of AR is its potential to address geographic barriers in rural areas. By using AR, students in underserved regions can access the same cutting-edge tools and collaborative learning environments as those in urban centers. AR platforms like JoinXR enable remote collaboration, allowing rural students to connect with experts and industry professionals across the state and beyond.

Policy Recommendations

1. **Expand AR Pilot Programs in Rural and Underserved Schools:** Scale up existing AR initiatives to more schools in rural Maine and other underserved regions across the U.S. Focus on early integration in middle school curricula, where students are most receptive to STEM career opportunities.[7]

2. **Partner with Local Organizations for Career Pathways:** Collaborate with organizations like JMG (Incorporated as Jobs for Maine's Graduates, Inc.) to create Extended Learning Opportunities (ELOs) that connect AR learning with real-world career pathways, particularly in life sciences and biotechnology.

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van, and John Sweller. "Cognitive Load Theory and Complex Learning: Recent Developments and Future Directions." *Educational Psychology Review* 17 (2005): 147–177. https://doi.org/10.1007/s10648-005-3951-0.
[6] Cakir, Recep, and Omer Korkmaz. "The Effectiveness of Augmented Reality Environments on Individuals with Special Education Needs." *Education and Information Technologies* 24 (2019): 1631–1659. https://doi.org/10.1007/s10639-018-9848-6; Ip, Horace H. S., and Cindy Li. "Creative and Collaborative Learning through Immersion, Interdisciplinary and International Perspectives." In *Creativity in the Twenty-First Century*, 135–150. 2021. https://doi.org/10.1007/978-3-030-72216-6_9; Rothbaum, Barbara O., Paul Anderson, Emily Zimand, Larry Hodges, David Lang, and Jason Wilson. "Virtual Reality Exposure Therapy and Standard (In Vivo) Exposure Therapy in the Treatment of Fear of Flying." *Behavior Therapy* 37 (2006): 80–90. https://doi.org/10.1016/j.beth.2005.04.004; Lorenzo, Gregorio, Joan Pomares, and Alejandra Lledó. "Inclusion of Immersive Virtual Learning Environments and Visual Control Systems to Support the Learning of Students with Asperger Syndrome." *Computers & Education* 62 (2013): 88–101. https://doi.org/10.1016/j.compedu.2012.10.028.
[7] Deodeshmukh, Rutuja. *STEM Engagement for Middle and High School Girls: Implementation, Challenges, and Lessons Learned.* 2022.

3. **Develop Professional Development for Teachers:** Provide ongoing training for teachers in rural areas to integrate AR into their STEM curricula effectively. These efforts should include teacher workshops and AR kit loans to ensure broad access.

4. **Prioritize Equity and Inclusion in AR Deployment:** Ensure that AR initiatives are accessible for students with disabilities and communities with limited access to essential services, using AR's immersive capabilities to support a diverse range of learning needs.

Conclusion

Integrating AR into STEM education offers a promising solution to address learning gaps and inspire the next generation of STEM professionals, particularly in rural and underserved areas. By providing immersive, engaging learning experiences and connecting students with real-world career opportunities and pathways, AR can play a pivotal role in the future of equitable STEM education.

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