

Supporting Teacher Self-efficacy and TPACK: Teaching Louisiana Wetlands Using Virtual Field Trips

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Abstract: Education about natural environments and their connection to ecosystems has the potential to foster environmental literacy and stewardship. Fostering environmental awareness in students helps them to learn about STEM topics in nature through hands-on classroom lessons with immersive experiences. Virtual reality technology serves as an educational tool that provides immersive learning experiences, which makes it relevant to developing environmental knowledge. A virtual reality themed professional development program was created to equip STEM teachers with virtual reality skills to immerse students into simulated field experiences. Integrating virtual reality technology into the teaching of Louisiana wetlands, helps put STEM concepts in a real-world context that is relatable to teachers and students living in these areas. This study draws insight from the teachers' learning experiences as they participated in the professional development program.

Keywords: Teacher self-efficacy, TPACK, Louisiana wetlands, Virtual reality, STEM education, Teacher Professional Development

Introduction

The Next Generation Science Standards (NGSS) empowers teachers to shift learning from rote memorization to engaging students in developing and applying the Disciplinary Core Ideas and Crosscutting Concepts to explain phenomena (real life observations of nature) and using the Science and Engineering Practices to solve real world problems. Global climate change as an environmental crisis is an example of a real-world scientific phenomenon that has gained much attention throughout the years of public debate of its legitimacy, showing the necessity for strengthening environmental literacy. Anthropogenic environmental problems leading to the loss of biodiversity and habitats, increasing pollution and sea levels, and decreasing access to clean water lead the way to sustainability discussions in which institutions of higher learning are in a unique position to lead (Ralph & Stubbs 2014, Sharp 2002). Incorporating these authentic problems into formal learning provides a culturally relevant place-based approach localizing students understanding of environmental science, which allow students to make personal connections to the scientific concepts and enable them to build lifelong scientific interests, thus promoting effective STEM education (Feinstein, Allen, & Jenkins 2013). Therefore, it is important that teachers are knowledgeable in and skilled at employing teaching strategies that can help students learn more about their environment, which in the context of this study is the Louisiana wetlands.

Louisiana has unique environmental issues that impact residents' daily lives. As populations shift and migrate from rural to urban areas, cities are facing challenges associated with urban flooding, outdated drainage infrastructures, and water quality deterioration. Flood frequency and severity is becoming more common. Louisiana residents have historically experienced multiple flooding events while state and federal agencies still struggle to properly assess risk and provide mitigation measures. Wetlands lessen the destructive effects of storms and floods, cleanse water from pollutants, recharge groundwater supplies and provide shelter and food for many kinds of wildlife (Stefanakis 2019). Hence, it is vital that students learn about the importance of Louisiana's wetlands and how it protects their natural environment.

Virtual reality technology gives a simulated experience of a real-world scenario permitting the user to have a powerful feeling of the experience digitally. The integration of virtual reality in instructional delivery has gained notable recognition in research studies. Virtual reality's inherent design fosters a sense of presence which enables teachers and students to fulfill experiential learning needs (Adžgauskaite, Abhari, & Pesavento 2020). Virtual reality also poses a workable solution for helping students learn abstract concepts, compared to the traditional classroom instruction that uses textbooks, lectures, and physical labs (Nersesian, Spryszynski, & Lee 2019). In addition, virtual reality promotes digital literacy, which is a student's ability to use digital media in processing and retrieving information for the purpose of learning and acquiring knowledge. This makes VR an educational tool that teachers can employ in their instructional practice for immersing students in Louisiana's wetlands, and other ecosystems, through virtual field trips and exploration. Teachers are central to designing digital learning experiences and providing quality education for their students (Engeness 2021). Teachers' knowledge of virtual reality technology makes the teaching process exciting and more effective (Patterson & Han 2019). However, the lack of virtual reality skills in some teachers leads to the absence of virtual reality utilization in STEM education. Investing in teacher professional development programs that provide virtual reality training enable teachers to conceptualize fresh insights for classroom teaching, learning and engagement. The professional development program used for this study focused on providing a rich learning content of Louisiana wetlands and virtual reality to equip teachers with the necessary knowledge, skills, and resources to implement virtual reality activities.

Theoretical Framework

Teacher Self-efficacy

Described by Albert Bandura in 1977, self-efficacy theory explores the role that the individual's opinion of their own ability play in determining their success. Self-efficacy can determine the decisions that people make and choices they aim for. For example, people general avoid the tasks in which they do not feel competent in while selecting tasks and activities that they feel skilled in (Schunk & Pajares 2009). The basis of self-efficacy theory is that the level of knowledge and skills a person has, to carry out a specific task will determine a person's judgment and ability to perform such tasks. Self-efficacy amongst teachers has been a focal point for research studies relating to instructional delivery and suggest that teachers with greater self-efficacy are more talented teachers (Bautisa & Boone 2015). Additionally, research demonstrates that student interest and learning in STEM subjects and career pathways have something to do with the role of their teachers (Nadelson, Seifert, Heffinger, & Coats 2013). Teachers' level of impact in STEM education is contingent on their level of self-efficacy to teach STEM subjects (DeCoito & Myszkal 2018). Studies have shown that teachers who are knowledgeable and adequately equipped with the resources for delivering STEM instruction have a higher level of self-efficacy to engage their students in STEM curriculum (Kelley et al. 2020). This stipulates that STEM teachers with low-self efficacy may possibly limit students' ability to gain extensive STEM knowledge (Kelley et al. 2020). Teachers with higher self-efficacy are prone to develop new and innovative methods for STEM instructional delivery, help students succeed, and persist with students who have difficulties (Nadelson et al. 2013).

TPACK

The Technological Pedagogical Content Knowledge (TPACK) framework is an effective framework used for creating, executing, and assessing technological curriculum and instruction (Niess, 2011). The TPACK framework was proposed by Mishra and Koehler (2006) as a guide for education technology integration, while providing context to what teachers should know to teach with technology. Koehler, et al. (2007) highlighted the relevance of the TPACK framework, by defining successful teaching with educational technology as a "multi-dimensional process that requires understanding the representation and formulation of concepts using technologies, pedagogical techniques that utilize technologies in constructing ways to teach content." The successful integration of technology in STEM instructional delivery begins with ensuring and enhancing the teachers' TPACK ability (Farrell & Hamed 2017). The TPACK framework shows an interconnection among three knowledge areas which are content, pedagogy, and technology, and it's the connection of these three knowledge areas that produces the requisite skills to effectively integrate technology in the classroom (Koehler & Mishra 2009). The TPACK framework has become a compelling mechanism for technology integration to improve instructional delivery and student learning and is therefore seen as an important framework for effective teaching with technology.

Methodology

This research study employed a qualitative research methodology to describe the teachers' experiences as they learned about Louisiana's wetlands and used virtual reality as an educational tool for exploring the natural environment. The teacher participants were recruited based on their interest in learning how to incorporate virtual reality activities into their secondary STEM classes. Data was collected in the form of observations, surveys, and documents (action research and lesson plans). The research study took place in Southeastern Louisiana as a virtual reality focused teacher professional development program, which began in the Summer of 2021 with the first cohort of teachers. Activities carried out in the program included workshop sessions on Louisiana wetlands, using 360-degree cameras to take pictures of a natural environment, virtual tour of wetlands, using virtual reality headsets in immersing oneself in subject matter, field trips to some Louisiana wetlands, development of action research and lesson plans, simulation of wetlands, and participation in a virtual action research community. Guided by an observation protocol, observations of the training sessions captured the teachers' experiences as they engaged in the different sessions of the virtual reality professional development program, providing a rich context for analysis. A document analysis was conducted on the teacher's virtual reality action research and lesson plans to help learn about the teachers' integration of content, technology, and pedagogy. The surveys served as a tool to learn about the teachers' instructional practice before and during the virtual reality professional development program.

Findings

Qualitative data analysis describes changes in teachers' self-efficacy and TPACK to implement virtual reality in their classroom; it shows that the teachers were confident to develop action research and lesson plans after attending professional development sessions, and observations reflected improved ability to implement a virtual reality classroom. The teachers' self-efficacy was discovered through their experiences such as: performance, vicarious, social persuasion, and physical & emotional state. Also, the teachers' TPACK were made apparent through the different knowledge areas which were: technology, pedagogy, content, technological pedagogical, technological content, and pedagogical content. The training sessions on Louisiana wetlands was informative and helped teachers to build their content knowledge, while the simulation and virtual reality training sessions developed the teachers' pedagogy and technology knowledge. This led to the teachers' ability to recognize the unique role they would be playing in engaging their students in learning about Louisiana's natural environment, ecosystems, and wetlands.

As the teachers participated in the virtual reality professional development program, it was observed that they became knowledgeable and skilled to talk about Louisiana wetlands, setup and configure virtual reality 360-degree cameras and headsets, build a field kit simulation of Louisiana wetlands, develop lesson plans, and implement a virtual reality lesson in their classroom. Observations captured the experiences of the teachers as they engaged in these activities; collaborations between teachers were a common sight as they worked together in carrying out tasks, challenges were faced and overcome as the teachers learned to setup virtual reality technology, and lessons were learned from the PD trainers and teacher participants.

One of the teachers who carried out a virtual tour of the Caminada Headlands of Louisiana with her students, shared her classroom experience with the action research community. The teacher's presentation showed her proficiency of Louisiana wetlands, virtual reality techniques and good pedagogy. In her words, "the virtual tour was very hands-on in explaining Louisiana coastlands and economic importance of the Caminada headlands, and why building barriers through wetlands was important to protect the ecosystem." Also, the teacher's presentation indicated a good integration of content, technology and pedagogy knowledge which is an important aspect of TPACK. The shared experiences within the virtual action research community allowed for further discussion and collaboration with other teacher participants on integrating virtual tours for exploring the Louisiana wetlands in their classroom teaching.

Conclusion

Environmental education provides learning experiences that can catalyze a passion for science, nature, and a lifetime of environmental stewardship; however, teachers often employ traditional approaches (e.g. lectures, textbook reading) to teach environmental science, which may not be as engaging to stimulate the interest of students.

Finding ways to enhance the teaching and learning of the environment is important in developing environmental knowledge, problem-solving skills to address environmental issues, and ensuring a sustainable future. This research study considered virtual reality technology as an educational tool to explore, teach and learn about a natural environment, in the context of the Louisiana wetlands in the United States. A virtual reality themed professional development program was studied, which served as a tenet to build teachers skills, knowledge, and overall competence to integrate virtual reality in environmental science classrooms. The teacher participants acquired knowledge in using virtual reality technology to explore the Louisiana wetlands and bring those learning experiences to their instructional delivery. Hence, this research study promotes innovative research in teacher development in a way that adds to the STEM Education field and body of knowledge of teacher professional development, from an educational technology standpoint. The study provides insight for school districts on indicators that contribute to productive utilization of teacher professional development. The professional development of teachers enhances the provision of quality education to students for achieving student success. Likewise, this research study provides information to potentially guide future development and delivery of STEM learning through virtual reality technology.

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