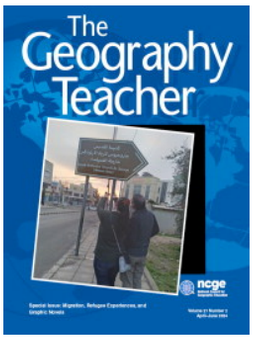

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LESSON PLAN

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Promote Environmental Awareness and Care by Creating a Virtual Reality Tour for the Local Community

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Introduction

This innovative lesson plan incorporates virtual reality (VR) technology to foster environmental awareness and care in late primary-age students. Drawing on the place-based education approach and social constructivism in the lesson design, students participate in collaborative project-based learning. The students' task involves creating a VR tour to showcase local environmental issues, their causes, and potential solutions. In tackling real-world environmental issues, students advance their digital and geographical literacies and deepen their community ties. Finally, this lesson plan can be extended to offer a multidisciplinary learning experience, merging diverse subjects to cultivate knowledge, skills, and attitudes beyond conventional subject boundaries.

Background for Instructors

Environmental education has become increasingly important as human beings continue the extensive exploitation of nature and threaten the existence of other living creatures on Earth (Demirbas 2017; Palmer 1998). Both environmental and geography education aim to bridge the connection between learners and the world, fostering a deeper comprehension of the bond between humans and their environment (Bodor 2016). Several curriculum standards have documented the critical need to raise children's environmental awareness and care (National Council for Curriculum and Assessment 1999; Minister of Education 2018; Heffron and Downs 2012). However, the excessive amount of time children spend online (Beresford et al. 2023) inevitably compromises their chances to experience the physical world, which in turn could lead to disconnection from the local natural environment and decrease their sensitivity and responsibility for environmental conservation (Grover 2009; Louv 2008).

VR is a computer-simulated platform that lets users immerse themselves in a realistic three-dimensional (3D) environment through use of specific equipment (Linowes 2015). Teaching and learning with VR technology has been applied to develop learners' environmental awareness and care (Plechatá et al. 2022; Sulisworo et al. 2022). However, empirical findings mainly were based on instructional pedagogy that positioned students as consumers of VR content, as opposed to students as content creators (Morales, Bang, and Andre 2013). Fewer studies explore the effectiveness of a "learner-as-creator" approach regarding VR in education (Huo, Wang, and Zhao 2023; Luo et al. 2021). Creating VR content in a project-based learning setting has been articulated to be able to facilitate meaningful learning experiences by creating authentic VR artifacts that were meaningful to them (Huo, Wang, and Zhao 2023; Morales, Bang, and Andre 2013). The VR project experience enables students to construct authentic VR artifacts, fostering immersive and personally relevant learning experiences. This approach deepens knowledge retention and skill construction through active participation and meaningful project involvement (Morales, Bang, and Andre 2013).

This lesson plan is designed to provide a meaningful learning experience for children by leveraging the capabilities of VR technology to increase children's engagement with local environmental issues and further their environmental awareness and care. This lesson plan employs the place-based education approach (Smith 2002; Sobel 2004), with the goal of connecting students to their local communities and environments. It is designed to make learning more meaningful and impactful by weaving local contexts and experiences into the educational context (Yemini, Engel, and Ben Simon 2023). In addition, this lesson plan is grounded in social constructivism, emphasizing the essential role of student interactions, discussions, and sharing in the process of co-constructing knowledge (Adams 2006; Vygotsky 1978). Students actively engage in collaborative learning activities, including brainstorming, researching, developing ideas, creating, and sharing (Akpan et al. 2020). The integration of the place-based education approach and social constructivism occurs through the implementation of project-based learning (Bell 2010). Children are encouraged to collaboratively and proactively take the lead in identifying their local community's environmental issues, investigating potential causes, suggesting viable solutions, and ultimately creating a place-based VR tour to present their research findings. Put simply, students will construct a virtual representation of local environmental issues, their causes, and potential solutions with geographic tools (e.g., 3D photography) and geographic information (e.g., the location of air pollution). This hands-on approach not only offers an

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opportunity for children to learn about the technology behind VR but also instills a sense of responsibility and ownership over their local environment. This approach conceptually aligns with the method of creating spatial stories (De Certeau 1984; Elwood and Mitchell 2012) to promote learners' community engagement (Kim 2023). By embedding learning within the context of local environments, the creation of spatial stories allows learners to articulate their spatial experiences and establish meaningful connections with their surroundings, thereby enhancing their understanding of and commitment to community involvement (Hall et al. 2020). The primary goal of this lesson plan is to increase children's sense of environmental awareness and care by allowing them to deepen their understanding of their surroundings. Children will be inspired to become protectors of their community, understanding the importance of preservation and sustainable practices.

Learning Goals

1. Understand VR technology's interactive and immersive features to promote environmental awareness and care.
2. Develop digital literacy by engaging in a place-based VR tour project that explores the community's environmental issues, their causes, and their potential solutions.
3. Enhance geographical investigation skills, capturing both the physical environment and its intricate relationship with human inhabitants, all within a VR content creation context.
4. Develop proficiency in incorporating various geographical tools, such as maps and images, for investigating and analyzing environmental issues, their causes, and their solutions.
5. Foster a deep appreciation for local communities by exploring the lives, cultures, and professions of its residents, emphasizing their bond with the surrounding environment.
6. Cultivate a heightened awareness of the local natural environment, understanding its intrinsic relationship with the lives of its inhabitants, and inspiring a sense of responsibility toward conservation and sustainability.

Guiding Question

How can creating a VR tour that explores a local environmental issue, cause, and solution change students' environmental awareness and care?

Target Audience

Primary school students in grades 4 to 6, aged 10 to 12 years

Time

Six hours is the total time allocation. The breakdown for each section is as follows: one hour dedicated to the introduction section, four hours for the development section, and one hour for the closure section. Each section's overview includes an estimated time for every step, which is provided for teachers' reference.

Standards

National Geography Standards:

- #3 How to analyze the spatial organization of people, places, and environments on Earth's surface (The World in Spatial Terms).
- #10 The characteristics, distribution, and complexity of Earth's cultural mosaics (Human Systems)
- #14 How human actions modify the physical environment (Environment and Society)
- #15 How physical systems affect human systems (Environment and Society)

Lesson Overview

In this lesson, based on the place-based education approach (Smith 2002; Sobel 2004) and social constructivism, students collaboratively embark on an insightful journey to explore local environmental issues, causes, and solutions and then create a VR tour to represent their findings and perspectives. The lesson is structured into the introduction, development, and closure sections. The lesson commences with an engaging video on global environmental issues, leading to student discussions on local environmental issues. Students are tasked with developing a VR tour detailing a local environmental problem, its origins, and its potential solutions. Through hands-on activities, students use Street View Download 360 and CoSpaces Edu to craft and refine their VR presentations, incorporating feedback from peers. The project culminates with students presenting their VR tours and participating in a reflective discussion on environmental awareness and care. Students will use VR technology not just as a tool but also as a platform for active engagement and advocacy in environmental sustainability. This approach highlights the synergy between environmental and digital literacy, empowering students to contribute meaningfully and digitally to sustainability efforts in their local community.

Materials/Resources Needed

1. **Software**
    I. CoSpaces Edu: Browser Version (https://www.cospaces.io/). Choose between the Basic version or the Pro version. The Pro version incurs a subscription fee of $50 per year. Detailed differences between the Basic and Pro versions are presented here: https://www.cospaces.io/pricing. Considering the implementation of this lesson plan, the primary differences between the Basic and Pro versions include the number of CoBlocks, the objects available to students, and the limit of 1,000 views for a shared VR tour. First, the restricted number of CoBlocks may directly impact the interactivity of a VR tour. For

instance, the "go to scene" CoBlock is exclusively available in the Pro version. This particular CoBlock can turn an object into a "door" to the next scene, enabling a more immersive experience. Conversely, in the Basic version, users of the VR tour must use the scene selection button at the bottom, which is less immersive. Second, the richness of a VR tour's presentation is directly influenced by the number of available built-in objects, but using external copyright-free images can help overcome this limitation. Finally, the view limit of 1,000 times for a shared VR tour, which is part of the Basic version, is unlikely to significantly impact a classroom-level project. Teachers are advised to utilize the 30-day Pro trial before choosing the version that best suits their specific needs and circumstances. Relevant information is available on the second page of the CoSpaces Edu Educator Kit below.

II. CoSpaces Edu App, available on Android and iOS devices.
III. Street View Download 360 App at https://svd360.istreetview.com/.

2. **Hardware**

I. Google Cardboard–style VR headsets with a control button for interacting with VR content on a smartphone
II. Android or iOS smartphones with screen sizes compatible with the VR headset's screen capacity
III. Laptops
IV. A whiteboard with a projector

3. **Manual and tutorials**

I. CoSpaces Edu VR Best Practices: https://assets.website-files.com/63da5edbbe116035895fc86d/64b551256899c9e4de87f851_CoSpacesEdu-VR-in-education.pdf
II. CoSpaces Edu Educator Kit: https://assets.website-files.com/63da5edbbe116035895fc86d/64b56863ef0b49062a38f1ab_CoSpaces-Edu-getting-started-kit_compressed.pdf
III. Creating in CoSpaces Edu, beginner tutorial: https://www.youtube.com/watch?v=2WWCnNjeMzM
IV. CoSpaces Edu 360° Tours, CoSpaces Edu key applications: https://www.youtube.com/watch?v=Mi5MYVpAmuU
V. Street View Download 360 app tutorial: https://svd360.istreetview.com/

4. **Teaching and learning materials**

I. Documentary: *Causes and Effects of Climate Change* by National Geographic (2017): https://youtu.be/G4H1N_yXBiA?si=G8cnY5unUnskkRld
II. Newspapers, websites, and interviews about local environmental issues (optional)
III. CoSpaces Edu VR example, Glenmerry Green Spaces: https://edu.cospaces.io/WXP-NAW
IV. Student worksheet (Appendix A in the supplementary material)

5. **Assessment materials**

I. Environmental awareness and care questionnaire adapted from the assessment of Bergman (2016) (Appendix B in the supplementary material)
II. Presentation marking rubric (Appendix C in the supplementary material)
III. Pool of questions for end-of-project reflective discussion (Appendix D in the supplementary material)

Preparation

Before beginning, teachers are encouraged to read the VR Best Practices Manual. The manual employs plain language to describe what VR is, its educational benefits, potential risks when used with young children, safety concerns, key safety recommendations, and additional resources. Teachers should familiarize themselves with CoSpaces Edu by utilizing the provided manuals and tutorials, which include the CoSpaces Edu Educator Kit; Creating in CoSpaces Edu, beginner tutorial; and CoSpaces Edu 360° Tours, key applications. It is important to note that these official materials may contain some outdated information. For instance, the user interface depicted may differ slightly from the current version. However, the interfaces presented in these materials are conceptually similar to the current ones, which should not present significant difficulties for teachers. Additionally, the tutorials may showcase features and resources exclusive to the Pro version. Teachers should also become acquainted with the Street View Download 360 app as well as the local environmental issues that students might choose for their VR projects. Finally, this lesson involves an intensive selection of group activities. Thus, teachers are recommended to create a mixed-ability group list beforehand. The recommended group size is three, as students will be involved in creating a VR tour featuring three scenes. The first scene will present an environmental issue, the second scene will report on the causes, and the third scene will share possible solutions. In a group of three, tasks can be equally divided, ensuring a balanced workload. Moreover, with three members, decision-making can be more democratic. If disagreements arise, the third member can often help mediate and find a compromise.

Lesson Instructions

Introduction Section: Understanding Our Community's Environmental Issues

The introductory section (see Table 1) engages students in understanding how global environmental challenges have local impacts. Starting with a thought-provoking video, students will

Table 1. Overview of the introduction section.

Introduction section				
Step	Estimated time	Activity	Objective	Assessment
1	10 minutes	The teacher plays the documentary *Causes and Effects of Climate Change*, which illustrates a global environmental issue, emphasizing the dramatic changes our planet has experienced.	Generate student interest and awareness about global environmental challenges.	Formative assessment: Pose the question: "What are some ways we can see big Earth problems right here where we live?" and assess students' initial reactions and responses on the worksheet.
2	10 minutes	Divide students into mixed-ability groups of three to discuss local environmental issues they are aware of or have observed. Students need to record their answers on the provided worksheet. If necessary, the teacher can supply resources such as newspapers, websites, and interviews to assist with their research.	Encourage students to tap into their personal experiences and recognize local manifestations of global issues.	Formative assessment: Ask a few groups to share their discussions, ensuring a variety of issues are highlighted.
3	10 minutes	The teacher uses the whiteboard to compile and categorize the local environmental issues students discussed.	Identify common environmental themes or concerns within the local community.	Formative assessment: Highlight emerging patterns or frequently mentioned environmental issues, prompting a brief discussion on their importance.
4	15 minutes	The teacher provides each group with a smartphone and a VR headset, then demonstrates how to use the VR headset to navigate the example VR tour: Glenmerry Green Spaces. Before the session, to save time, the teacher must install the CoSpaces Edu app on the smartphones and preload the VR tour, after which the smartphones should be placed in the VR headsets.	Familiarize students with the potential of VR as an educational tool.	Formative assessment: Ask students how this type of VR tour can be used to showcase our local community, particularly in raising awareness of local environmental issues.
5	5 minutes	Present the project overview and requirements, emphasizing the exploration of local environmental issues, their root causes, proposed solutions, and the creation of a VR experience.	Ensure that students are aware of what they're expected to achieve by the end of this section.	Formative assessment: Ask students to paraphrase the objectives or discuss their initial thoughts, ensuring clarity and comprehension.
6	10 minutes	Issue the "Environmental Awareness and Care Questionnaire" as a pre-survey.	Assess the students' levels of environmental awareness and care before the project engagement.	Summative assessment: Establish the baseline of students' environmental awareness and care before the project engagement.

VR = virtual reality.

discuss known community environmental issues. Subsequently, students are briefed on the project requirement: to craft a VR experience that presents their research on a local environmental issue, its potential causes, and plausible solutions.

Development Section: Creating a VR Tour to Represent a Local Environmental Issue, Cause, and Solution

The development section (see Table 2) entails students selecting an environmental issue within a local community, investigating the issue, identifying possible causes, and proposing applicable solutions. It also includes designing a VR tour to showcase an environmental issue, causes, and solutions. Students will learn to use the Street View Download 360 app and then create a VR tour using CoSpaces Edu by uploading 360° photos, adding objects, creating interactivity, and setting up navigation.

Figure 1 demonstrates one example of a VR tour created by using CoSpaces Edu to showcase the impact of climate change on Dublin. Students will then test their VR tour and refine it by seeking peer feedback and making necessary adjustments. The development section concludes with students preparing their presentations for the closure section.

Closure Section: Presenting Our Environmental Insights

The closure section (see Table 3) begins with student groups taking turns to present their VR tours, explaining environmental issues, causes, and solutions. After each presentation, peers give constructive feedback, facilitating summative peer assessment and collaborative learning. The session ends with a reflective discussion on environmental awareness and a survey to assess any changes in the students' environmental awareness after engaging with the project.

Extension

This lesson plan, informed by the place-based education approach and social constructivism, offers a meaningful and impactful project-based learning environment where students work collaboratively to investigate a local environmental issue, its causes, and potential solutions and then create a VR tour to represent their research findings. The main aims are to facilitate students' environmental awareness and care by enhancing their connection to, and sense of environmental responsibility for, the local community. There are several extensions that are worth further investigation.

First of all, to elevate the learning experience beyond the geography curriculum for 4th to 6th grades, this lesson plan has the potential to be linked to computational thinking, a key concept within the STEM education field, as this lesson plan involves block-based coding experience. Engaging in block-based coding experiences is one of the primary strategies for developing computational thinking (Gleasman and Kim 2020; Kastner-Hauler et al. 2022). For instance, students can apply the concept of algorithmic thinking by sequentially arranging CoBlocks to enable a virtual figure to report on local air pollution causes. Additionally, the concept of debugging will be utilized as students test and refine their draft VR tour, identifying and resolving any issues.

Table 2. Overview of the development section.

Development section				
Step	Estimated time	Activity	Objective	Assessment
1	10 minutes	Each student group will discuss and then select one environmental issue identified in the previous section.	By the end of this step, each group should select one environmental issue they are most passionate about or feel is the most pressing.	Formative assessment: Each group presents a short overview of the environmental issue they've chosen and explains why they chose it.
2	60 minutes	The teacher allocates one laptop to each student group. After selecting an issue, students will use online resources to investigate its causes and brainstorm solutions. For example, the Irish Environmental Protection Agency website (https://www.epa.ie) offers real-time GIS environmental data, such as air quality, and details the causes of air pollution in Ireland. The teacher prompts students to investigate the underlying factors and develop solutions by examining the lives, cultures, and professions of residents in the local community. Students will then use the worksheet to construct a mind map detailing their reasoning and to document the online sources that support their research and suggested solutions. A mind map is a nonlinear diagram that visually organizes tasks, words, concepts, or items around a central subject.	Students are expected to be able to identify at least two or three primary causes for their selected environmental issue and propose at least two feasible solutions.	Formative assessment: Each group creates a mind map based on the selected environmental issue, showcasing the causes and corresponding solutions, and documents the references on the worksheet.
3	20 minutes	The teacher shows students how to download 3D photos from Google Maps using Street View Download 360 and then import them into CoSpaces Edu. Students learn to enrich their VR tours with objects, multimedia, and narrative audio and to use CoBlocks for interactivity. For those with the CoSpaces Edu Pro version, the teacher covers using "door" objects to switch scenes.	Students learn to use the Street View Download 360 app to download 3D photos from Google Maps, creating panoramic backgrounds for their VR tours in CoSpaces Edu. They also explore CoSpaces Edu's additional features to enhance their VR tour designs and interactivity.	Formative assessment: Students are expected to follow the teacher's instructions to practice the demonstrated technical skills. The teacher regularly checks for student questions or clarifications.
4	120 minutes	Students create a group account on CoSpaces Edu and then plan three storyboard scenes on the worksheet: an introduction to the environmental issue, a description of its causes, and a presentation of proposed solutions. Afterward, students begin working on their VR tours, enhancing them with CoBlocks, objects, multimedia, and narrative elements.	Students design a VR tour to convert their research and ideas into a visual and interactive format, aiming to educate others about the chosen environmental issue, its causes, and potential solutions.	Formative assessment: The teacher assesses students' progress by checking their ongoing work and provides support if necessary.
5	20 minutes	Once the draft VR tours are complete, groups will swap and test each other's projects. During this process, they will offer constructive feedback on clarity, interactivity, and the overall user experience.	Students refine their VR tours based on peer feedback to ensure they effectively communicate the environmental issue, its possible causes, and the proposed solutions.	Formative peer assessment: Students evaluate their peers' draft VR tours and provide constructive feedback by responding to the five scaffolding questions on the worksheet. They will then use the worksheet to record the feedback received and refine their tours in preparation for the final presentation.
6	10 minutes	The teacher prepares students for group presentations, explaining that each group has two minutes to showcase their VR tour and present the chosen environmental issue, causes, solutions, and creation process. The teacher reviews the marking rubric, highlighting criteria for clarity, research depth, solution feasibility, and tour effectiveness.	Prepare students to present their VR tours, articulating the chosen environmental issue, its causes, and potential solutions, as well as sharing their experience of project engagement.	Formative assessment: The teacher will assess students' progress by reviewing their presentation preparation.

R = virtual reality.

Second, the project has the potential to evolve into a community outreach initiative, where students apply their findings and proposed solutions in real-world scenarios, thus fostering community engagement and contributing to local environmental sustainability. This practice aligns with the Common Core State Standards for English Language Arts (Council of Chief State School Officers & National Governors Association 2010), particularly in speaking and writing. Effective communication of their research findings and solutions requires students to support their claims with logical reasoning and relevant, accurate data, demonstrating a deep understanding of the subject. The use of cohesive language and clear phrasing in both speaking and writing will further clarify the relationships among their claims, the reasons for these claims, and the evidence, which should all be drawn from credible sources. Engaging in this community outreach initiative has the potential to inspire students to pursue careers in environmental protection and natural resource management in the future, which resonates

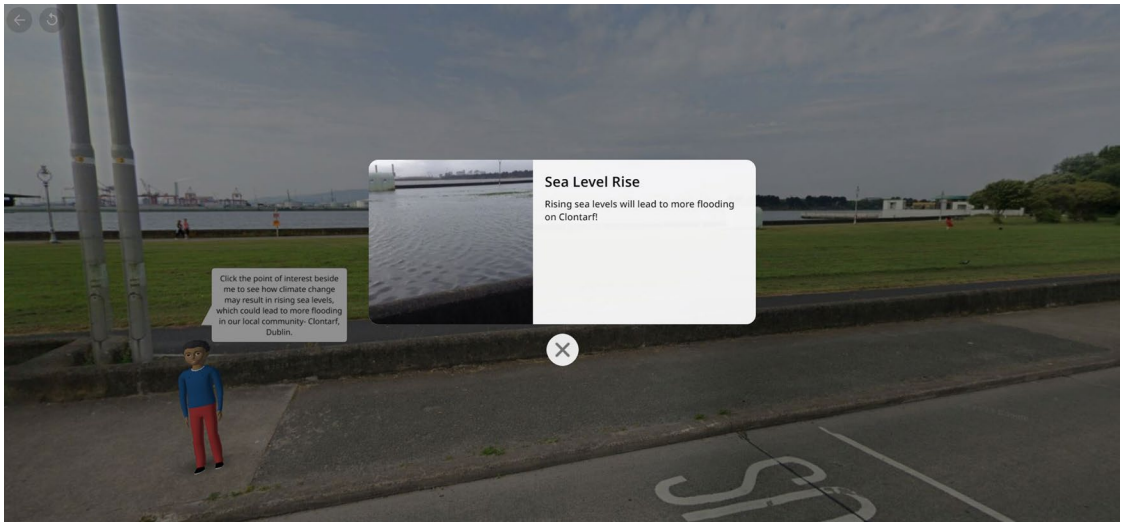

Figure 1. Example of one scene in a virtual reality tour created using CoSpaces Edu to showcase the impact of climate change on Dublin.

Table 3. Overview of the closure section.

Closure section				
Step	Estimated time	Activity	Objective	Assessment
1	30 minutes	Group presentation activity: Rotate the groups to ensure that each one has the chance to present their VR tour for a maximum of two minutes and explain their chosen environmental issue, its causes, proposed solutions, and how they translated this information into a VR tour format.	Allow students to articulate their research and explain their VR tour design choices.	Formative assessment: The teacher uses the "Presentation Marking Rubric" to grade the presentations on clarity, depth of research, feasibility of solutions, and effectiveness of the VR tour.
2	10 minutes	Allow one minute for peer feedback after each presentation. Encourage constructive comments on strengths and potential areas for improvement.	Foster a collaborative learning environment and help students refine their communication and presentation skills.	Summative peer assessment: Students evaluate their peers' work and provide constructive feedback.
3	10 minutes	Reflective discussion: The teacher concludes the project-based learning activity with a discussion reflecting on the students' changes in environmental awareness and care, using the pool of questions to guide the conversation.	Urge students to contemplate how the project learning experience enhanced their awareness and care for the environment.	Summative assessment: The teacher hosts a reflective discussion to qualitatively evaluate the changes in students' environmental awareness and care.
4	10 minutes	Issue the "Environmental Awareness and Care Questionnaire" as a post-survey.	Assess the students' levels of environmental awareness and care after the project engagement.	Summative assessment: The teacher uses the post-survey to quantitatively evaluate the changes in students' environmental awareness and care.

VR = virtual reality.

with the Common Career Technical Core (National Association of State Directors of Career Technical Education Consortium/National Foundation 2012) at a later stage.

Third, the student-made VR tours can be featured on the school website, spotlighting students' achievements and insights. This exposure can further enhance the students' confidence and motivation to learn. For optimal impact, it is advisable to upgrade to the Pro version of CoSpaces Edu, as it removes the Basic version's viewer limitation of 1,000 views, ensuring wider accessibility.

In summary, this lesson plan has great potential to offer a multidisciplinary learning experience by integrating various subjects, allowing students to gain knowledge, skills, and attitudes that transcend traditional subject boundaries. It enables an educational experience rooted in place-based learning education and social constructivism, emphasizing the interconnectedness of different disciplines.

Disclosure Statement

No potential conflict of interest was reported by the author(s)

Notes on Contributor

Hsiao-Ping Hsu is an assistant professor at Dublin City University's Institute of Education. With a PhD in learning technologies from the University of Texas at Austin (2019), he specializes in digital learning, mixed-reality, computational thinking, and digital literacy. Before academia, Dr. Hsu was a geography teacher with six years' experience. His awards include the 2017–2018 Reimagine Education Award in

Virtual/Augmented Reality, Taiwan's Top 100 Curriculum Innovations (2017), and awards from AECT in 2018 for instructional design and international educational technology practices. In 2019, he received the Foxconn Education Foundation's Graduate Student Research Fellowship in Technology Innovation.

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