Supporting Technology Career Interest and Prosocial Attitudes through Virtual Reality Co-creation in the Classroom

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Figure 1: Students engaging in VR co-creation and examples of their completed virtual scenes. Left: students using VR headsets; center: a student displaying their creation on a tablet; right: examples of student co-created scenes.

Abstract

Grounded in creative learning and culturally responsive computing, this case study investigates the use of virtual reality (VR) co-creation as a meaningful context for K-12 students' engagement with spatial computing. Fifth through eighth grade students (n = 68) learned about the history of hip-hop and collaboratively built VR music video sets centered on messages they wanted to share. Findings suggest that this intervention significantly increased students' interest in pursuing technology careers and their motivation to make a difference in their communities. Additionally, it helped elicit a range of VR design ideas grounded in students' values, affirmations, and issues they cared about. We conclude by discussing the affective and creative affordances of this approach. We also discuss considerations for integrating VR co-creation into the classroom, including how asymmetric access to devices and tools may help scaffold collaboration.

Index Terms: virtual reality, co-creation, creative learning, culturally responsive computing, education.

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1 Introduction

As virtual reality (VR) becomes more accessible in schools, the immersive qualities that make it a powerful medium for education may also present challenges for students learning to use VR and develop virtual experiences [2]. Compared to 2D interfaces, using VR introduces an added layer of spatial complexity and can require a specific competency in navigating immersive interfaces and controls [37]. And on a broader scale, this learning curve has contributed to a VR development skills gap, where limited specialized expertise in VR has constrained innovation in the industry [31]. As a result, greater attention is needed to understand how classrooms can introduce students to spatial computing practices in empowering ways that support students' continued engagement in developing this skill set. How VR is integrated into a broader curriculum can play a critical role in shaping the quality of students' learning experiences, their confidence in engaging with VR as a technical practice, and their interest in further pursuing technology-related pathways.

Creative learning may offer a valuable approach for this integration. This learner-centered framework is characterized by experiences in which students explore knowledge through creation and tinkering [28, 38]. It is guided by the principle that students learn best when they work on projects they care about, engage in playful experimentation, and learn alongside peers [28]. Advancements in VR have positioned it as a promising new tool for creative learning and the development of computational skills. Through a combination of interactive 3D simulations, head-mounted displays, and real-time body tracking, VR enables highly immersive learning experiences in which students can exercise agency over their digital surroundings [18]. Learners can jointly explore and represent ideas in a spatial environment by manipulating 3D objects and creating virtual scenes [22, 25]. What distinguishes VR from other digital tools for creative learning is its capacity to induce a greater sense of presence, or the feeling of "being there" in virtual environments. Thus, creating in VR allows students to situate themselves inside of the worlds they are creating and building upon. These qualities of VR have been associated with increases in students' self-efficacy, motivation, and interest, which are important predictors of knowledge gain, career choices, and academic persistence [18, 15, 1, 40].

That said, creative learning for VR pedagogy, especially in collaborative contexts, remains an understudied research topic [10, 36]. Working on creative projects that students care about has the potential to help students persist through the unique challenges of VR [34], and adding collaboration may support knowledge construction through dialogue and observation of peers [19, 33]. Additionally, previous scholarship on creative learning outside of VR suggests that this approach can help improve students' technical confidence, increase their interest in STEM, and equip them with career ready skills [23, 12]. Further research is needed to understand the affordances of creative learning for integrating VR into K-12 classrooms, and how these learning activities should be designed.

In this paper, we investigate VR co-creation in the classroom through a case study with 68 students in the fifth through eighth grade. Grounded in the prior research, we formulated the following research questions:

- **RQ1:** How can VR co-creation support students' interest in technology careers and civic responsibility?
- **RQ2:** What broader affordances does VR co-creation offer for students' engagement with spatial computing?
- **RQ3:** What design considerations emerge for integrating VR co-creation into K-12 classrooms?

We explored these questions by designing a VR co-creation activity that incorporated cultural responsiveness and multiple configurations for student collaboration. We present evidence to suggest the affective and creative affordances of this approach. This included significant increases in students' interest in pursuing technology-related careers and sense of civic responsibility, as well as the elicitation of a range of VR designs grounded in students' values, affirmations, and issues they cared about. We also use this case study to examine collaborative considerations for integrating VR co-creation into K-12 classrooms. In doing so, we contribute to research on VR pedagogy by demonstrating how culturally responsive VR co-creation can serve as a meaningful entry point for K-12 students' engagement with spatial computing.

2 Related Work

In this section, we situate our work within existing scholarship on creative learning, culturally responsive computing, and collaboration in VR. We use this scholarship to inform the design of both our VR co-creation activity and study.

2.1 Creative Learning and Culturally Responsive Computing

Creative learning, a learner-centered approach informed by constructionist learning theory, highlights creation and tinkering as pathways for exploring knowledge [28, 38]. It consists of four key elements: projects (i.e., working on meaningful projects), peers (i.e., engaging in social learning), play (i.e., playful experimentation during learning), and passion (i.e., learners persist through challenges when working on projects they care about). In this paper, we place creative learning in dialogue with culturally responsive computing as a method for igniting passion during the learning process. Culturally responsive pedagogy is an instructional approach that integrates students' cultural knowledge and lived experiences into education to foster more relevant and effective learning [8]. Building on this approach, culturally responsive computing positions students' cultural knowledge as a resource for creative and technical production [35]. These experiences place an emphasis on validating the perspectives and identities of learners and serving as a site for reflection on intersectional identities [29]. This consideration for sociocultural dimensions of computing systems has helped promote STEM participation, especially among learners from marginalized backgrounds [11, 14]. In this case study, we use culturally responsive computing as a method for promoting engagement with and interest in spatial computing. Specifically, we centered the creation activity on the history of hip-hop and its pillar of knowledge, which emphasizes self-knowledge and knowledge of one's community.

2.2 Collaboration in VR

An emerging research agenda in VR has begun to uncover what is possible when students collaborate within the medium [33]. Findings have shown that collaborative VR learning activities can support learning, teamwork skills, and peer-driven goal setting [6, 17, 25, 39]. That said, creating and collaborating in VR is not without its challenges. The open-ended nature of creation tasks and immersive nature of VR can increase cognitive load [21]. Collaborative tasks can introduce the risk of unequal participation, particularly when more confident team members dominate the conversation [3]. Co-creating virtual scenes across multiple networked devices in a co-located environment may hinder communication and result in thematically disjointed artifacts [13]. And on a practical level, providing each student in a classroom with a VR headset for collaboration can be a financial barrier. Recent studies have examined how to address these challenges by adding structure to the collaboration process, including the use of collaboration scripts and asymmetric collaborative configurations in which students assume different roles, tools, and/or devices [5, 7, 39, 24]. However, research on different approaches to VR co-creation in classroom settings remains limited. We address this gap by examining multiple configurations for student collaboration during the creation activity.

3 Methods

This section describes the details of this study, including the participants, procedure, data collection, and data analysis.

3.1 Participants

In this IRB-approved study, participants consisted of fifth through eighth grade students (n = 68) from a school located in Alabama, USA. Students (Boys = 36, Girls = 28, Prefer not to say = 4) were between 10 and 13 years old and identified as Black and/or African American (n = 53), multiple racial and/or ethnic categories (n = 7), Hispanic, Latino, Latina, and/or Latinx (n = 3), White (n = 1), declined to respond (n = 3), and a racial group not listed (n = 1). Prior to this study, 27 students experienced VR headsets more than 20 times, 19 experienced VR 2-10 times, 13 experienced VR once, 6 experienced VR more than 10 times, and 3 never experienced VR. Parents were sent consent forms that allowed them to opt their children out of participation. Assent was obtained from students at the start of the study. While all students engaged in the VR co-creation activity as part of their classwork, data from students without parental consent and/or student assent were excluded from the analysis.

3.2 Virtual Environment

Students used KaiXR[1], a digital learning platform that supports videos, readings, short answer questions, and low-barrier VR development through a virtual makerspace (See Figure 3). In this study,

[1] www.kaixr.com

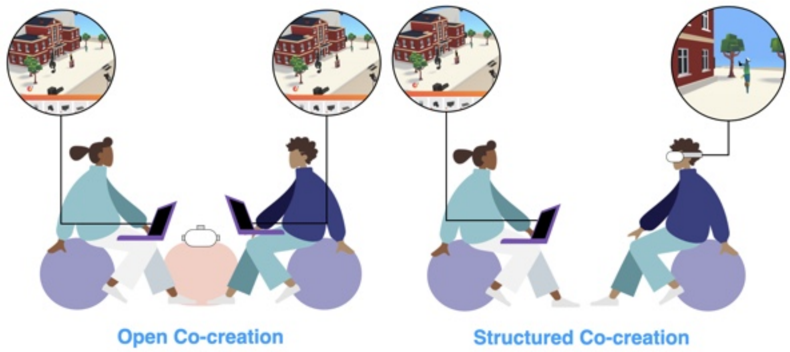

Figure 2: Collaborative configurations used during the study. Left: open co-creation; right: structured co-creation.

students used the makerspace to co-create their VR scenes by dragging and dropping 3D objects from an asset library into a networked virtual environment. These 3D objects could then be modified using transform, rotate, scale, and animate features. The platform enables building through a 2D browser interface on a tablet or in a VR headset. However, to reduce technical complexity, students were instructed to build using their tablet only. Students could view their scenes from a third-person, bird's-eye perspective on a tablet, or from a first-person perspective on either a tablet or VR headset.

Figure 3: Interface of the KaiXR makerspace.

3.3 Hardware

Each pair of participants was provided with a Meta Quest 2 headset (1832 × 1920 resolution per eye, 104.00° horizontal FOV, 98.00° FOV, 90Hz refresh rate, and six-degree-of-freedom inside-out head and hand tracking, 503 g), two hand controllers (126 g), and 1-2 tablet devices based on their collaborative configuration.

3.4 Procedure

The study took place over two days across six classes. On Day 1, after completing a pre-survey, students participated in the learning and planning phases of the study. During the learning phase, students learned about the history of hip-hop through videos and written materials. The knowledge pillar of hip-hop is the culture's philosophical underpinning, characterized by both self-knowledge and consciousness of social and political issues [4]. In alignment with creative learning's principle of passion and culturally responsive computing's emphasis on recognizing students' lived experiences, we framed the VR creation activity around the knowledge pillar to give students the chance to draw from their own experiences while creating their virtual scenes. Specifically, they were tasked with creating a virtual music video set centered on a message they wanted to share. During the planning phase, students worked in pairs to brainstorm their message and how they wanted their virtual environment to look.

On Day 2, students completed the building phase. After receiving instructions on how to collaborate, students spent 15-25 minutes building their virtual music video sets with tablet and headset devices (See Figure 1). Finally, students completed a post-survey about their experience.[2]

3.5 Collaborative Configurations

To explore considerations for collaboration during VR co-creation, students made their virtual music video sets under one of two collaborative configurations, which were assigned at the class level: open co-creation (n = 21) and structured co-creation (n = 47) (See Figure 2). In open co-creation, two students freely co-created their virtual environments without assigned roles. Using separate tablets, both students built the virtual environment simultaneously and had the option to view their scenes in a nearby VR headset. At the halfway point, students were instructed to view their environment in VR if they had not already done so. In structured co-creation, two students co-created their virtual environment while assuming separate roles: the builder and the VR guide. The builder used a tablet to build and modify their virtual scene. The VR guide viewed the scene in VR, offered spatial guidance regarding the placement and size of objects, and made sure it looked good from a VR perspective. At the halfway point, students had the option to switch roles.

Configurations were assigned to classes based on class size, with the goal of balancing sample sizes across configurations, along with other practical considerations. For example, an educator recommended that the youngest class would be better suited for the open co-creation configuration. Despite these efforts, unforeseen school logistics resulted in unequal sample sizes between the two configurations.

3.6 Data Collection and Analysis

Survey items were adapted from existing scales in collaboration with an educator to make the language more accessible to middle school students. Using the pre- and post-survey, the following constructs were measured both before and after the intervention:

- **Civic Responsibility:** Civic responsibility was measured using one item adapted from [27]: "It is my responsibility to make things better for my community."

[2] Students who were not in attendance on Day 1 completed an abridged version of the lesson on Day 2.

- **Interest in Technology Careers:** Interest in technology careers was measured using one item: "I think technology will be a part of my job someday."

In the post-survey, students responded to open-ended questions about their experience. This included prompts asking to describe the message of their creation, what it was like to build as a team, what they would add if there was more time, and the challenges that they encountered. We used students' descriptions of their scenes to create the following measure:

- **Creation Theme:** The theme of the scene co-created by students.

The post-survey also measured the following:

- **Teamwork Quality:** Teamwork quality was measured using two items on a 5-point Likert scale (1 = Not at all, 5 = Extremely) adapted from [16]. Items included: "During the makerspace activity, my partner and I worked well as a team." and "During the makerspace activity, my partner helped our group in important ways."
- **Creative Thinking:** Creative thinking was measured using two items on a 5-point Likert scale adapted from [30]. Items included: "After the makerspace activity, I feel excited by my new ideas." and "After the makerspace activity, I feel ready to come up with solutions to problems."
- **Enjoyment:** Enjoyment was measured using one item adapted from [9]: "How much fun did you have in the makerspace activity?"
- **Self-efficacy:** Self-efficacy was measured using one item: "I am confident about understanding new technology."

Finally, researchers took field notes documenting their observations during sessions.

Measures collected in both the pre-survey and post-survey were analyzed using Wilcoxon signed-rank tests. Measures collected only during the post-survey were analyzed descriptively by calculating response distributions for each Likert item. Open-ended responses were thematically analyzed using open inductive coding and exploratory analysis. This method emphasizes identifying recurrent topics relevant to our research questions and using them to form broader themes [20]. Two researchers coded the responses and came to a consensus on the codes.

4 Results

Our results highlight several affordances of culturally responsive VR co-creation for K-12 students' engagement with spatial computing. We first report changes in students' interest in technology careers and civic responsibility (RQ1), followed by broader affective and creative affordances of the activity (RQ2). We then present preliminary observations and considerations related to collaborative VR creation in the classroom (RQ3).

4.1 Increased students' interest in careers involving technology and civic responsibility

Our results indicated significant differences in students' interest in technology careers (M_{pre} = 3.26, SD_{pre} = 1.05, M_{post} = 3.78, SD_{post} = 0.96) and sense of civic responsibility (M_{pre} = 3.63, SD_{pre} = 0.88, M_{post} = 3.93, SD_{post} = 0.83) following the VR co-creation activity (See Figure 4). Students' interest in technology careers significantly increased after the activity, $V = 528.5$, $p < 0.001$. Descriptively, 30 students reported increased interest, 34 students stayed the same, and only 4 decreased from pre- to post-survey. Students' civic responsibility also significantly increased after the VR co-creation activity, $V = 356$, $p = .006$. Descriptively, 23 students reported increased civic responsibility, 38 stayed the same, and only 7 decreased from pre- to post-survey. Together, these findings suggest that the VR co-creation activity was associated with gains in students' interest in technology-related career pathways and motivation to make a change in their communities.

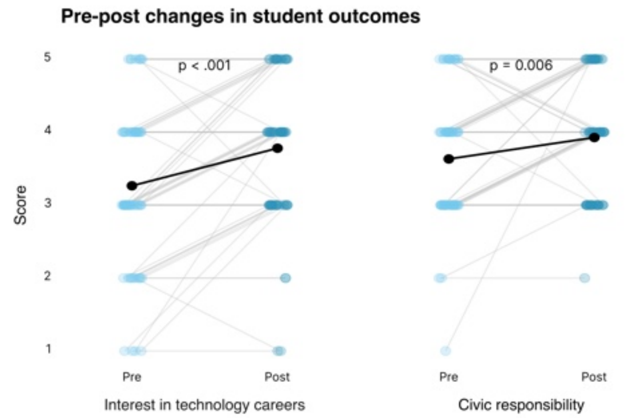

Figure 4: Changes in technology career interest and civic responsibility before and after the VR co-creation activity.

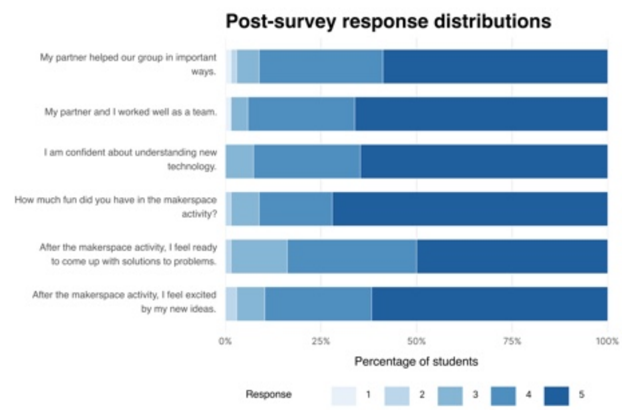

Figure 5: Distribution of post-survey responses.

4.2 Promoted joyful learning

Survey and open-ended responses revealed that the VR co-creation activity was a joyful learning experience for students. A majority of students used positive language to describe their collaborative experience, many of whom described it as fun. For example, responses included *"[Building] the music video scene as a team was very fun and humorous. It also made us become closer friends as we went through it"* and that building was *"really fun and had me very engaged, especially with the headset."* Some reasons cited by students for this enjoyment included having fun playing around with the VR creation tools and working with their partner. Joyful learning was further evidenced by Likert scale items (See Figure 5). Students reported high levels of enjoyment during the activity (M = 4.62, SD = 0.69), with 72% selecting the highest response option. Similarly, students reported high levels of teamwork quality (M = 4.51, SD = 0.71), creative thinking (M = 4.40, SD = 0.62), and self-efficacy (M = 4.57, SD = 0.63) after the VR co-creation activity. Overall, these results suggest affective affordances of integrating VR co-creation activities into the classroom.

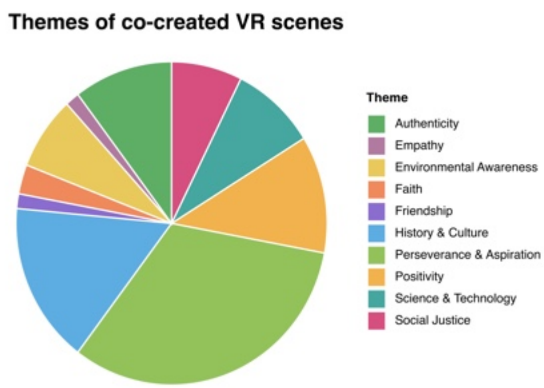

Figure 6: Themes of VR scenes co-created by students.

4.3 Elicited range of VR scene ideas

The messages that students embedded in their co-created virtual music video environments addressed a range of personal, social, and cultural topics (See Figure 6). The most common theme was perseverance and aspiration, where they encouraged others to pursue their goals and persist through challenges. For example, they described messages as *"you can do anything you put your mind to"* and to *"never give up."* Others used their worlds to share messages of authenticity, inspiring others to *"be yourself."* Several projects also engaged explicitly with social justice. One student wrote *"The message we shared was about ice and it connects to hip hop because people say problems about the world through hip hop."* Another explained to classmates that their scene addressed threats to voting rights in the United States. Other themes included environmental awareness, history, culture, and positivity. These findings demonstrate that VR co-creation provided not only an opportunity for students to engage with spatial computing tools, but also a space for reflecting on their identities and communities. Moreover, the culturally responsive nature of the activity helped elicit a range of VR design ideas.

4.4 Preliminary observations of collaborative creation in the classroom

Students generally had a positive experience under both collaborative configurations. While a majority of students reported having no challenges during the co-creation activity, some of the ones cited included communication, idea generation, and VR technology related hurdles. Notably, two students under the open co-creation configuration highlighted issues involving pairs deleting each other's assets. One student wrote *"I had challenges with working with my partner, he kept deleting my stuff."* and another stated *"yes my teamate wanted to add diffrent thgings so i removed them becuas we didnt need them."* It is also worth noting that despite representing a larger portion of the sample, no one in the structured co-creation reported this issue. Additionally, the second author observed that compared to her prior experiences running co-creation sessions without VR headsets, this session involved noticeably fewer behavioral issues and fewer verbal reports of students deleting each other's assets.

This activity also served as an environment for teamwork skills. Some pairs were able to work through challenges through communication and negotiation: *"Me and my partner had two different opinions and ideas about some things. But it made me just enjoy my experience because we decided to merge those ideas."* Researchers observed that introducing VR headsets played a role in allowing students to practice verbal communication. Given that those students had access to different tools, one of which involved a head-mounted display, communicating was important and they had to rely on voice as their primary form of communication.

5 Discussion and Conclusion

In this case study, we investigated the use of VR co-creation as a meaningful context for K-12 engagement with spatial computing. Results revealed a number of affective and creative affordances of this approach. First, there was a significant increase in students' interest in technology careers. Because the curriculum design sat at the intersection of VR, creative learning, and culturally responsive computing, students benefited from the combined self-efficacy and motivational strengths of each approach [26, 11]. Interest is a precursor to knowledge gain [18]. Therefore, by igniting students' interest in technology pathways, culturally responsive VR co-creation can be a promising outlet for learning spatial computing. Second, results demonstrated a significant increase in civic responsibility, or students' motivation to make a change in their community. This extends past research demonstrating VR's capacity to encourage prosocial behavior [32], highlighting how this can emerge in a co-creative context. Third, building in VR together became a site for students to reflect on their own perspectives, engage with issues impacting their communities, and affirm themselves and their classmates. The use of a culturally responsive activity helped elicit students' ideas for a range of VR scenes and knowledge-sharing became a pathway for exploring spatial computing tools. This activity positioned students not only as users of VR, but also as motivated, critically engaged creators of (future) VR experiences.

This case study also illuminates considerations for integrating VR co-creation activities into K-12 classrooms, such as determining how students should collaborate. While in this study students reported positive experiences under both examined collaborative configurations, we present preliminary evidence to suggest that adding structure through asymmetric device and tool access may support teamwork and verbal communication skills. Because building tools were only accessible on the tablet, this set-up may have helped reduce some networked-world collaboration challenges, such as mitigating student's deletion of each other's content. Classrooms aiming to integrate co-creation as a VR activity may consider the introduction of device specific roles to help encourage positive collaboration behavior.

That said, there are a number of limitations to consider. Due to unforeseen school logistics, we did not have a large enough or equally distributed sample size across collaborative configurations to draw reliable comparisons of quantitative data. Therefore, future work should continue to examine the efficacy of these configurations. Moreover, because several post-survey measures appeared to show ceiling effects, future work should consider alternative approaches for assessing learning outcomes with this age group.

Acknowledgments

The authors would like to thank the students for participating in this study, as well as their classroom teacher and school leadership for their support in facilitating this study. The authors also thank Su Kim and Elizabeth Garcia for their assistance in preparing the study materials, Arturo Paracuellos for his engineering contributions to the project, Anna Carolina Muller Queiroz and Gustav Bøg Petersen for their feedback on study design, and Mahlet Ayele for her assistance with thematic analysis of qualitative data. The first author is supported by Stanford Accelerator for Learning's Joyful Learning Seed Grant.

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