Chapter 6. Designing Virtual Reality User Experiences for a Nonprofit Organization: Perspectives from Engineering Graduate Students and Community Partner

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Abstract. In this exploratory qualitative study, a new graduate-level engineering course focusing on the intersection of virtual reality and augmented reality (VR/AR), user experience (UX), and social justice partnered with a local nonprofit organization to design a VR experience for middle school students. The purpose of our study was to better understand how the community partner and graduate students define and perceive success, what obstacles they think they experience, and what characteristics of the community partner they think would be ideal for such a VR/AR course, which is a highly technical domain for UX application. By analyzing students' reflections and interviews, coupled with the community partner interview, we found that even though most of the participants considered the project to be successful, their definitions and perceptions of success in collaboration varied and were closely associated with mutual positive engagement instead of the deliverable. Both the students' and community partner's personalities and attitudes, and even the instructor's, impacted their collaborative experience, which include qualities such as flexibility, open communication, maturity, and easygoingness. Although students described obstacles such as the lack of technical expertise, infrequent communication, and insufficient feedback, they also recognized the flexibility, creativity, and leadership that were necessary to successfully complete the project. We recommend clearly defining the expectations of the collaborative process by discussing the technical needs, assisting students in identifying potential approaches, and emphasizing the importance of establishing a relationship and communication channel with the community partner early on and throughout the project.

Recently, virtual reality and augmented reality (VR/AR) technology and user experience (UX) have been increasingly explored in writing and technical communication studies (Jones & Gouge, 2017; Tham, 2017; Tham et al., 2018). For

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example, VR/AR has been used for purposes such as audience analysis, multimodality, and peer review (Duin et al., 2016). In engineering, 3D VR/AR laboratories are frequently used to help students conduct complex analyses that may otherwise be cost-prohibitive (Vergara et al., 2017). Likewise, in the last decade, there has been a strong emphasis on promoting social justice in both technical communication (Agboka, 2014; Colton & Holmes, 2018; Jones, 2016, 2017; Walton et al., 2019) and engineering (Baillie et al., 2014; Leydens & Lucena, 2018; Lucena, 2013; Queiruga-Dios et al., 2021).

While promising, VR/AR presents unique challenges due to the advanced technical nature of the technology and its relative novelty. In addition, applying VR/AR technology when collaborating with external organizations, particularly nonprofit organizations involved with social justice issues, can present unforeseen challenges. Therefore, we must delve further into collaborator interactions to develop a better understanding of the impact of highly technical UX collaborations on both students and community partners, particularly at the graduate level.

In this case study, we analyze the collaboration between a graduate-level UX engineering course on VR/AR at a regional Midwestern university and a local nonprofit organization that serves underprivileged middle school students. Since this edited collection is centered on the idea that "for collaborations to work, all partners must buy in and experience benefits" (Introduction, p. 20), we focused our study on the perspectives of those engaged in collaboration, which in our case, included the graduate students and the community partner. The following questions guided our inquiry:

- How do students and the community partner perceive successful or unsuccessful collaborations? How do their perceptions impact their experience?
- What community partner characteristics affect the perceived impact of collaborations with graduate students in VR/AR courses?
- What obstacles stand in the way of productive UX on VR/AR partnerships? How can we work to overcome these obstacles?

Literature Review

For the last two decades, service-learning pedagogy has been widely advocated by educators in both technical communication (Bowdon & Scott, 2003; Cargile Cook, 2014; Sapp & Crabtree, 2002) and engineering (Bielefeldt et al., 2010; Litchfield et al., 2016) for improving students' professional skills. There are various models for incorporating service learning: for example, students can collaborate with a nonprofit community partner individually for an internship or a capstone project, or they can collaborate collectively with other students on a class-based or client-based project. In this section, we provide an overview of existing scholarship on measurement of project

impact, characteristics of community partner, and obstacles and solutions in collaborations.

Measurement of Project Impact

There are three main ways to measure the effectiveness or impact of a service-learning project in the classroom: through examining student experience, quality of the deliverable, or community partner experience.

Focus on Students

Although there is a plethora of research addressing benefits and challenges of collaborating with nonprofit community partners for class-based projects, little scholarship in technical communication or engineering addresses both students' and community partner's perceptions on project impact. For example, in technical communication research, methods such as interviews, reflections, response papers, and quantitative and/or qualitative surveys (Bourelle, 2014; Matthews & Zimmerman, 1999; Sapp & Crabtree, 2002; Scott, 2008; Soria & Weiner, 2013; Walsh, 2010) are commonly used to assess student collaborative experience. Similarly, in engineering case studies that focus on a class-based service-learning project, researchers mostly measure student learning outcomes using surveys (Brown & Chao, 2010; Queiruga-Dios et al., 2021, Riley & Bloomgarden, 2006; Tiryakioğlu et al, 2009) and minimally address the community partner's perspective on the collaboration. Furthermore, most service-learning case studies tend to focus on undergraduate student experiences. As Richard Reddick and colleagues (2018) aptly pointed out, there is a lack of scholarship on the impact and effect of civic engagement on engineering graduate students. In fact, their study findings reveal that "engineering graduate students are not only motivated to serve in different community engagement capacities, but, moreover, find meaning in their service" (2018, p. 147).

Focus on the Deliverable

While success in collaboration can be measured using the quality of the deliverable that students produced for the community partner (e.g., Brown & Chao, 2010), Amy Kimme Hea and Rachel Wendler Shah (2016) warned that the deliverable is often used by "teachers and academics [to argue] for the value of and need for service-learning projects in technical communication" (p. 50). This is also in line with Juliette Butcher and Paul Jeffrey's (2007) argument that measuring success in collaboration using a tangible product "can generate an incomplete picture of achievement and fail to capture many (experiential) outcomes which may influence future collaboration intents or behaviour" (p. 1240).

Focus on Community Partners

Kimme Hea and Wendler Shah (2016) argued that in addition to having the instructor and student perspectives, it is crucial to hear from those "silent partners"

who collaborated with students in our projects; therefore, they interviewed community partners who were involved in various sections of a professional writing course. While Lynda Walsh's (2010) research collected data from both the community partners and students who collaborated on the same projects, her end-of-semester community partner survey focused on the deliverable that students produced, and the community partners' experience on the collaboration process was largely based on her own observations.

Characteristics of Community Partner

Based on his experience as a technical communication instructor and service-learning program coordinator, Robert McEachern (2001) listed common characteristics of nonprofit organizations for instructors to consider, which include "passion for mission" (p. 216), "atmosphere of scarcity," and "individuals [having] mixed skill levels" (p. 218). Kimme Hea and Wendler Shah (2016) were concerned that some of the field's existing views on community partners (such as the ones laid out by McEachern above) can be "hyperpragmatic" in that "we run the risk of constructing partners reductively as 'others;'" (p. 50) by (over)focusing on the efficiency of collaboration logistics and the quality of the deliverables. To create successful service-learning collaborations, they listed four productive tensions that they argued need to be negotiated:

> These tensions include four main paradoxes: receiving resources requires giving resources, community partners are both teachers and clients, partnerships must involve clear plans but flexibility, and meeting community partner interests requires meeting student interests. (2016, p. 54)

There are also other technical communication studies that focus on the logistics and expectations of the community partners. For example, J. Blake Scott (2008) recommended that instructors establish long-term partnerships with organizations that can then serve as community partners, while others recommend letting students identify and locate service opportunities that align with their interests/values (Henson & Sutliff, 1998; Huckin, 1997; Matthews & Zimmerman, 1999; Nielsen, 2016). In Rebecca Walton's (2007) interview study of executive directors and volunteers from nonprofit organizations as potential service-learning partners for technical communication courses, she called for instructors to clearly establish each stakeholder's role and expectations, as well as discussing and articulating the criteria and definition of a successful project with both the students and with the nonprofit organization. With the advent of online technical communication classes, instructors are encouraged to collaborate with community partners who are responsive, especially where students want more interactions with the client (Bourelle, 2014).

Obstacles and Solutions in Collaborations

Not surprisingly, the bulk of technical communication and engineering literature on service learning has focused on positive student outcomes or success stories. For example, in technical communication, only a few studies explicitly mention obstacles found in collaborations, such as the community partner's lack of communication or guidance on the project (Bourelle, 2014; McEachern, 2001; Walsh, 2010), locating appropriate service opportunities (Nielsen, 2016), or students seeing service learning as charity, struggling with their roles in an unclear non-academic setting, and experiencing conflict as a team (Matthews & Zimmerman, 1999). Similarly, in engineering courses that integrated service learning, students can struggle with being inclusive in an interdisciplinary team (Brown & Chao, 2010) or being proactive in connecting with the community partner (Tiryakioğlu et al., 2009).

In one of the few engineering case studies that describe obstacles in detail, Donna Riley and Alan Bloomgarden (2006) listed multiple challenges that students in an undergraduate engineering and global development course faced when collaborating with a local bakery to identify pollution issues. First, students were asked to explore engineering technical pieces as needed instead of given a structured problem to solve, so students needed more context for understanding this framework and leading the project. Second, communication broke down between students and the community partner because students were not actively consulting with them. Third, students were seen as experts, which the researchers felt "implicitly devalues the knowledge and expertise held by community members" (Riley & Bloomgarden, 2006, p. 57). Fourth, due to the time constraints of an academic semester, where students had to acquire engineering knowledge and principles on the subject matter before solving the problem for the community partner, they were unable to quickly provide solutions.

Certainly, there is already a large body of literature that identifies best practices in university-industry research collaborations that can be applied to service learning projects, such as mutual trust and good relationship; good project management; mutual understanding and appreciation of motivation, interests and needs; clearly specified objectives and expectations; frequent, clear and open communication and feedback; commitment and continuity of both partners; close alignment of expertise and interests of collaborating parties; and, agreements on project roles and responsibilities (as cited by Butcher & Jeffrey, 2007, p. 1242).

However, Butcher and Jeffrey's (2007) examination of doctoral students' perceptions of success in collaborations with external organizations found that "perceived success is correlated not with factors which describe the formal structure of collaboration, but with factors that portray the experience of working together" (p. 1248). Similarly, H. J. Littlecott and colleagues (2017) surveyed and interviewed academics and practitioners who collaborated on the same project to determine their perceptions of success, and the researchers found that even though both

stakeholders considered their project to be successful, where they based their positive views of success differed (e.g., deliverable/product versus process).

Below, we describe a case study in which we explore the complex dynamics when graduate students collaborate with external community partners. We start by describing the course design in detail, followed by the data collection methods and summary of findings. Finally, we discuss the case study in the context of relevant literature.

Course Design

Oakland University's (OU) ISE 5900/SYS 5900 Virtual and Augmented Reality course was designed by Smith in 2019 to help students develop technical VR/AR skills and learn UX methods, which they would apply when collaborating with organizations working on social justice initiatives in the Detroit metropolitan area. However, students could not choose the course based on the service-learning component, which was not listed in the course title or description and was first discussed in the introductory class. The instructor (Smith) had complete academic freedom and no constraints for content or partnerships. In addition to having lectures introducing theory, students participated in practicums where they could apply different UX methods found in *Universal Methods of Design*. For the purposes of the course, UX encompasses all aspects of the user interaction with the VR/AR system, and was addressed throughout the project lifecycle through discussions and feedback. Finally, students completed two projects in which they developed virtual or augmented reality applications, with the first being individually developed and the second being a collaboration with fellow classmates and a community partner. The 15-week course was developed with fully face-to-face (F2F) interaction in mind; however, due to the impact of COVID-19, we transitioned the course to fully online between weeks 9 and 10.

Reflection Assignments

Throughout the semester, students completed written reflection assignments. Reflections 1, 4, 5, and 6 focused on students' experiences in the class, with VR/AR technology, and with the community partner. Reflections 2, 3, and 7 connected students' projects back to course content including a subset of UX methods (specifically, design charettes and formal/informal interviewing) and VR/AR theory (presence, immersion, and fidelity) and encouraged deeper thinking about the material in the context of their work.

Projects

Students' course assignments included two hands-on projects (individual project and collaborative project, described below) where they developed a program

in VR or AR. For each project, students developed an outline or storyboard to articulate the planned user experience, content, and interactions when using the VR/AR system. In addition to technical course requirements (deploy projects in Unity), students were required to write in reflection assignments and project summary documents about how each project addressed social justice issues described in the United Nations (UN) list of sustainable development goals (United Nations, 2024). Using Unity Software, students developed a virtual environment and placed digital objects in the environment that users could manipulate using student-defined interactions. Each project had to include a minimum of five different virtual objects and interactions. The individual project included only technical development within Unity, while the group project also included working with an external stakeholder to design a VR or AR system based on the needs of that partner. Thus, the students incorporated theory and practically applied UX methods from class to the group project. The course projects were based on similar assignments from the VR for the Social Good Initiative at the University of Florida (http://www.vrforthesocialgood.com/) and La Trobe University's CSE_4AT_3 Advanced Topics in Computer Science (Virtual Reality) taught by Dr. Richard Skarbez (https://www.richardskarbez.com/).

Individual Project

For the individual project, students were required to identify a social justice issue that could be, at least in part, solved by the use of VR/AR. They then designed and developed a short VR/AR activity that would address this issue by leveraging the inherent capabilities of VR/AR to make the user experience engaging. This project focused on building students' individual technical skills needed to develop applications in VR/AR with a compressed timeline (three weeks). For example, one student developed a VR game to encourage recycling by teaching users how to sort trash and recycling. When users sorted materials by placing them in the correct bins, they received visual feedback that they did the task correctly (i.e., their hands stayed "human"). When they did it incorrectly, for example, by throwing away a recyclable item, users' hands would incrementally turn into zombie arms.

Collaborative Project

After completing the individual project, students formed groups for their longer (10-week) collaborative project. The purpose of this project was to continue applying technical skills developed in the individual project while also incorporating collaborations with team members and the community partner. Because this graduate course was small (five students), the students chose to work as a single group. In line with recommendations from researchers such as Danielle Nielsen (2016), students were encouraged to identify potential community partners for the project who aligned with their interests and values. To ensure that at least one potential partnership was identified, the course instructor also sought

out partners in the local area. The criteria for these partnerships were that they were nonprofit organizations focusing on social justice issues and were willing to partner with students on a project using VR/AR technology. To ensure the community partner's flexibility, the course instructor clearly explained that this was a pilot course that may not result in a viable VR/AR product. While students were given about three weeks to identify partners, none of the students brought recommendations, and therefore only the two potential partners identified by the course instructor were discussed by the class. The students then met as a team and selected the community partner that they felt would be the best fit for their group and this course.

After that, students worked together, along with feedback from the community partner, to design and develop a VR/AR project that could help the partner in some way. To ensure accountability and feedback, every few weeks, students had in-class discussions and completed a "Sprint Review" (in Weeks 6, 10, and 13) by showcasing completed work to gather feedback from the course instructor and, when possible, the community partner. The initial course plan included 10 weeks in which students could meet with the community partner to collect data, refine ideas, and implement changes using skills and methods learned in the class. However, due to COVID-19, students were only able to meet in person for the first five weeks of the project timeline (Weeks 4–9).

Community Partner

Based on the criteria and timeline above, the students selected the Michigan Youth Project (MYP) as their partner for the course project because of the focus on the UN's Sustainable Development Goal #4: *Quality Education*. They were given contact information and encouraged to reach out to MYP to better understand how they could apply their technical skills for the benefit of MYP. Based in Pontiac, Michigan, MYP was founded by Maggie Razdar in 2019 (Michigan Youth Project, 2019). Pontiac is located near Detroit, which is often known for its high unemployment and crime rates (Stebbins & Guneson, 2019). Similar to Detroit's history, Pontiac was once a thriving community due to the automotive industry, but it has recently been struggling with declining population, infrastructure, and educational resources, along with high violent crime rates (Mack, 2019; Wingblad, 2018). After volunteering in school systems in and around Pontiac, Maggie saw the lack of resources available to students and wanted to ensure a better education. Her goal is building students into independent learners by helping them improve reading, writing, and communicating skills through research. During MYP's first year, Maggie worked with 5th grade students in the Pontiac school system, across several elementary schools. The following year, she continued working with eight of those same students, now 6th grade Pontiac middle school students. Throughout the academic school year, students who participate in MYP complete a project examining the past, present, and future

of their home city, and in this case, Pontiac, Michigan. The MYP participants' project would ultimately be presented to an audience of interested parties including their parents and community members. At the beginning of the partnership, MYP participants had just completed their projects about the past of Pontiac and were beginning to research the present and future.

The main social justice goal of the partnership was for OU students to introduce K–12 students in the local community to cutting edge technology like VR/AR, and to increase MYP participants' exposure to higher education. Through the process of co-developing a VR/AR project with OU students, the MYP participants would also see their ideas taken seriously and implemented into a project that could be shared with family or friends outside of MYP.

Project Outcomes

For this collaborative project, students were encouraged to own their learning by approaching or designing the project and applying their skills and new UX knowledge as they see fit. Students focused their design and development efforts highlighting research about the past of Pontiac from each MYP participant. Students developed a VR application for their project, also referred to as the VR "environment" or "world." The final project outcome was a VR environment with an interactive map of Pontiac including scenes highlighting six different MYP participant projects. OU students initially met with the MYP participants to learn about their projects and co-develop ideas. After initial meetings, students developed scenes based on MYP participant work, which focused on different elements of Pontiac history including music and arts, the General Motors plant, Woodward Avenue, Dr. Death (Jack Kevorkian), the asylum, and Chief Pontiac. Each scene included objects that could be selected to learn more details. After developing early project prototypes, OU students conducted informal interviews and usability assessments with MYP participants to determine how to improve the VR interactions in future iterations. Students completed as many changes as they could but COVID-19 interrupted course plans and limited access to lab computers. Therefore, to ensure that the MYP participants got some closure for the semester, the final project also included a video that could be shared with MYP participants showing the VR environment and available interactions, along with a description of the reasoning behind design choices and, finally, statements from each of the Oakland students about the overall experience and what they hoped the MYP participants could gain from it.

Technical Resources

As can be expected, a course aimed at developing VR/AR experiences requires a variety of technical resources. Each project required using free Unity software to develop a three-dimensional VR/AR project by using Unity's graphical user

interface along with C# programming. While the software could be downloaded and used on students' personal computers, rendering graphics in 3D can be computationally expensive and may exceed system capabilities of some personal computers. Therefore, the course also included unlimited access to computers in the Human-Centered Engineering Lab on the OU campus to ensure student success. After developing a project in Unity, students could deploy or implement their projects on a variety of VR/AR hardware available as a part of the course including the Microsoft HoloLens (AR), Epson Moverio BT-350 (AR), and Oculus Rift (VR). Projects could be deployed directly onto the HoloLens, which essentially has its own internal computer, and graphics could be played on the Moverio through YouTube videos. On the other hand, the Oculus requires a relatively powerful computer and a high-quality graphics card (NVIDIA GT 960 4GB/AMD Radeon R9 290 or better) to process the graphics in real-time. None of the students in this class owned a personal computer capable of processing Oculus programs and therefore any Oculus programs had to be displayed in the lab.

Methods

After receiving Institutional Review Board approval (Oakland University #1544716), the instructor informed all students in this course about the option to participate in a research study. Early in the semester, Chong, who served as the external researcher and co-principal investigator for this project, visited class to explain the consent and research process and to collect consent forms. Throughout the semester, Chong kept track of students who participated in this study, and Smith did not know which students participated until after final grades for the semester were posted. Likewise, Chong interviewed students one-on-one after the semester, which enabled students to openly describe their experience without the presence of their instructor, who only listened to the interview recordings after the semester ended.

Table 6.1. Participant Overview

Student Name (Pseudonym)	Degree Seeking	Background	Gender	Employment	Previous Unity Experience
Anna	M.S.	Computer Science	Female	Full-time	Yes
Milo	M.S.	Engineering	Male	Full-time	No
Charles	M.S.	Design	Male	Full-time	No
Joe	PhD	Engineering	Male	Full-time	No
Thomas	PhD	Engineering	Male	Full-time	No

In order to participate, students needed to sign an informed consent document, but all analyzable materials were part of the course content, and no additional work was required. The purpose of this design was to minimize the impact to students and to maximize participation in the study. All five students enrolled in the course elected to participate in the research study, and their demographics can be seen in Table 6.1.

Data Collection

The student materials that were analyzed include written reflections, completed projects, and an end-of-the-semester one-on-one online interview with Chong. The semi-structured interview allowed us to probe deeper into and seek clarifications on student responses and experiences without instructor presence. In addition to having student feedback, both of us solicited feedback from our community partner, MYP, by asking Maggie about her experience working with the graduate students, challenges faced, and recommendations for future collaboration, through an online interview at the end of the semester. All interviews were audio recorded and transcribed verbatim.

Data Analysis

Since this graduate course was offered by the instructor for the first time as an experiential pilot study, one of our goals was to gain insights into students' and community partner's experiences in terms of their collaborations that could improve future course offerings. Therefore, we used a qualitative research framework based on the grounded approach (Glaser & Strauss, 1967). This method allowed us to inductively analyze our data and identify themes that emerged.

Drawing from Meghan Barnes and Kathryn Caprino's (2016) method of analyzing service-learning reflections, we "searched for themes across the stories participants shared through written reflections and identified major themes and categories" (p. 564). Both of us acted as the analysts, where we individually read participants' reflections and listened to interview recordings to identify potential themes. Then, we discussed the themes we found based on our research questions and triangulated the data by corroborating our findings from multiple data sources (reflections collected throughout the semester and interviews) to ensure the quality and validity of our analysis.

Limitations

It is important to note that our study was based on entirely self-reported data and therefore limited to what the participants perceived. However, this perception is exceedingly important and merits further study. In addition, due to the disruptions caused by COVID-19, we were neither able to conduct user testing that

was necessary with the MYP participants nor interview them directly on their collaboration experience. We believe that their opinion should be considered in future work; however, this would require parental consent, which may be a challenge working with minors in UX work.

Findings

Community Partner Perspective

We were interested in examining specific needs from the community partner when collaborating with graduate students in particular. Therefore, we asked Maggie about her experience, expectations, view on success in collaboration, and recommendations.

Previous Experience and Expectations

In terms of previous collaborations with other partners through MYP, Maggie found that the main challenge with some partners is that "they get their ego involved . . . want to have their name tag on everything." Therefore, she recommended collaborating with organizations who share the same vision or goal. She believed that "educators are easier to collaborate with because they share similar goals."

While Maggie considered educators to be good collaborators, she also pointed out that even within university collaborations there can be significant differences in the partnership. She has now worked with undergraduate students and graduate students at OU in various capacities. Some students do not work directly with the MYP participants and instead work only with Maggie on the organization's websites and social media. Students from another class visit weekly to help MYP participants with their research, documentation, and communication, and Maggie found this to be helpful for the MYP participants because "seeing someone from university coming and helping them, they felt important because a lot of people don't give them credit and they feel like they have a voice."

While Maggie described positive aspects about all three types of service-learning approaches mentioned above, she made clear distinctions between collaborating with the graduate versus undergraduate students. Maggie does not have technical expertise in the VR/AR area; therefore, at first, she "had no idea" what the graduate students were doing for the project. Since the MYP participants who served as primary users had never experienced VR/AR technology prior to this project either, she had hesitations about the age difference between MYP participants and graduate students.

But after the project, Maggie was impressed that the graduate students "went to [the MYP participants'] level to collaborate with the kids." In her experience, undergraduate students were often "very timid with these kids," potentially because they are "afraid of Pontiac kids." She believed that when undergraduate students behave this way, it makes the MYP participants "even more uncomfortable"

because "they just want to be kids." Conversely, she considered the graduate students' interactions with the MYP participants to be "perfect" and "comfortable" possibly due to the graduate students being "more educated" or "older." Therefore, she speculated that that was why MYP participants were actively asking questions and being more engaged, and she considered this project to go above her expectation because "it is something that the kids are asking for again. With other programs, they never asked for them again. So that just tells me that . . . something impacted [these kids]."

Maggie thought the partnership had "been a great experience" for the MYP participants because it exposed them to new technology. Maggie believed that MYP participants realized that technology they may have previously viewed just as "fun" could also be used to learn and could even potentially turn into a career path: "They were talking about 'Wow, you could actually create games. You could actually go to college to do that instead of just playing.' So, their vision became broader. It helped them to see it differently now."

Success in Collaboration

When defining successful collaborations, Maggie listed four reasons why she considered this collaboration to be successful:

1. Having a common goal and honest communication to achieve that goal. She defined a successful collaboration as:
   > Collaboration is [being] able to work together and going back and forth and communicating openly, coming up with conclusions or coming up with ideas [that are] going to work, and analyzing and really being open about it . . . with collaboration you have a purpose of working on one thing and you want to see how are we benefiting from it.
2. The instructor's open-mindedness, open communication, and flexibility. She thought that the instructor was "easygoing," "communicated well," and she appreciated the fact that the instructor was willing to "take a chance on this project."
3. Engagement and interest from the MYP participants. Maggie saw how MYP participants benefited from an engineering project that was "interactive" and "practical" because they typically do not like to just "sit and research." This is why "the kids [are] asking for it again."
4. Engagement and interest from the graduate students. She described them as "easygoing" and "respected the kids." The MYP participants felt "included" and that they were "part of the group."

Recommendations

When asked what we could do to improve this collaboration in the future, Maggie said that she "can't think of anything." However, she did wish they "had more

time to even see more [of the VR projects]," and recommended introducing more collaborations and expanding the content to other domains.

Student Perspective

We were interested in examining graduate students' perspectives when collaborating with the community partner. Therefore, we asked students about what their expectations were, how they viewed their interactions with the community partner, what went well, and what they needed (but perhaps did not receive) in their interactions with stakeholders.

Previous Experience and Expectations for the Course

At the beginning of the semester, students were asked what expectations they have for the course (Reflection 1, Week 1). Out of the five students, only one (Anna) had prior experience using the Unity software; the other four students took the class primarily because they were interested in acquiring and enhancing skills and knowledge on VR/AR, with some expecting that the project would benefit their jobs (e.g., by collaborating with software developers more effectively or creating VR/AR projects that are resume-worthy).

Technical Expertise of Community Partner (Challenges and Benefits)

Students addressed the importance of understanding community partners' level of technical expertise for VR/AR in establishing expectations for the partnership. In their interviews, three students pointed out that the community partner's lack of knowledge about VR/AR resulted in minimal structure or stakeholder needs, which made the project challenging in different ways, for example:

- Charles had never worked with a nonprofit organization before and felt that he needed more information (e.g., scope and expectations) to move forward.
- Anna added that the lack of input required her team to "make a quick on-the-spot decision regarding scope and plan" and "just had to create it."
- Milo found it challenging to accommodate unrealistic expectations, for example, MYP participants wanted to have games incorporated into the scenes without realizing the amount of time and effort it would take.

Although Maggie and the MYP participants did not provide any technical requirements for the project, students also described the benefits of being able to lead the project:

- Milo, who is used to being "drilled" with technical questions at his engineering job, found that this collaboration was "not even stressful."

Instead, he was able to share in the excitement of "exposing kids to new technologies and trying to inspire them and . . . giving them new experiences and provoking their curiosity."
- Anna felt that the VR experience they designed "isn't being overshadowed by expectations an experienced user may have."
- Thomas added that "most of [the] times, you don't get all the information in [the] real world. You don't get exactly what you want. But here in this case, we got everything that we needed from them."

Communication with Community Partner (Quality and Frequency)

Students repeatedly mentioned the significance of working face-to-face with Maggie and the MYP participants by explicitly stating that they would have preferred increased interaction with the MYP participants to get more feedback or more substantial feedback. At the beginning of the project, students were able to meet with the MYP participants to watch them use the Oculus with an early project prototype. Even then, several students noted the difficulty of getting useful input from the MYP participants:

- Milo stated that the MYP participants "were unsure of how to give feedback," probably because "we were asking a lot from them for just being exposed to the technology."
- Joe found that watching students wearing the Oculus and reacting to the scenes, for example, saying, "no, that is not what I was expecting" was more helpful feedback than saying "you have done a really good job."
- Anna said the MYP participants "didn't really have a lot of input to give us on what they wanted this to be so we just had to create it . . . No input is kind of the same as giving us input in this case." She also found that the meetings were "chaotic" and "all a bit hectic" because they lacked structure.

As graduate engineering students, they were intentionally given the freedom to communicate with the community partner to gather the user feedback that they needed. Without specific directions on establishing a communication structure provided by the instructor, students had to be proactive in applying the data-gathering methods they learned in class. Watching the MYP participants interact in the environment in real-time allowed students to identify problems or challenges with the technical design, even though the client or users could not always articulate specific needs or requests. Therefore, Thomas wished that as a team, they could collect data via "questionnaires or feedback sessions." Likewise, Milo felt that more data collection using a survey was needed to measure the effectiveness of the VR environment they created, and that they "missed out on valuable data."

Students agreed that more frequent meetings with MYP participants would be helpful to gather useful information; however, they offered different

suggestions about how much interaction would be sufficient for this project. Students recommended daily (Charles), biweekly (Anna), weekly (Milo, Thomas), or monthly (Joe) meetings with the community partner. Students were originally scheduled to meet with MYP five times throughout the semester, but two meetings were canceled due to COVID-19. In fact, COVID-19 was considered by the students as the primary reason for not getting enough feedback due to both canceled in-person meetings and closed buildings.

Although students acknowledged the importance of frequent meetings, none of them requested or pursued additional meetings besides those set up by the instructor (before COVID-19) even when they were given the contact information and were encouraged to do so. Milo was the only student who acknowledged that the team could have been more "proactive" to reach out to the community partner through email, but he realized that "it really wasn't Miss Maggie we were trying to talk to; we wanted to talk to the students."

Time Commitment

All students in this graduate-level class were working full time and taking full-time classes, not to mention that some have families. Although all students wanted more feedback and more interactions with the MYP participants, two also recognized that they had limited time. Anna said, "there was rarely a time when we were all available," while Charles pointed out that "everyone is learning [Unity by] themselves and everyone has their full-time job while having this class."

Even with their busy schedules, Joe thought that while it was "difficult" to work on the weekdays, they were able to find hours to work the project during weekends before COVID-19, and that he actually enjoyed the process because "we used to drink, eat, and do our work" together in the lab and "it was real entertainment for us." Additionally, students' commitment to the project and community partner was evident. For example, Milo stated that his team would still be "willing to meet up with the students even after the end of the course to talk to them and present our project."

Definition of Success in Collaboration

At the beginning of the semester (Reflection 1, Week 2), students were asked "How would you define success in collaborations?" Four students mentioned goals or tasks being accomplished, three students mentioned satisfaction, and only one student mentioned effective communication as elements of a successful collaboration. Similarly, in Reflection 6 and during the one-on-one interviews, students were asked, "How did your collaboration work out? Would you consider it to be successful? Why or why not?" Four out of five students considered the collaboration to be a success. The common themes were goals were met with a deliverable for and satisfaction from the community partner, as seen in their responses in Table 6.2.

Table 6.2. Students' Definitions of "Success in Collaboration" Pre-collaborative and Post-collaborative Project

Student	Pre-collaborative project	Post-collaborative project
Anna	Any success in collaborations would be defined as completing the task at hand so that all parties are satisfied and, ideally, would seek this type of collaboration again.	Our collaboration with MYP worked out wonderfully . . . We took their goal of education, used the resource of the research they have done, added the VR element, and came up with something I'm proud of. Definitely a success. Lots of "oohs and ahs" from the kids. I think everyone is happy with the results as far as I know.
Milo	Success, to me, in collaborations is when everyone has something to bring to the table and work toward a common goal.	It would be considered a success because by the end of the project we will have achieved the goals we began with: communicating our message and having a deliverable for the students to see.
Charles	The success in collaborations is that every collaborator achieves one or a few of the objectives with an investment lower than doing it alone.	A successful project is result-oriented. The collaboration worked out partially and got interrupted by the coronavirus outbreak. Although the students got so excited about our work, I would not consider it to be successful because [of] the lack of opportunities for them to experience the experience we created.
Joe	Team collaboration is very important when the goal to achieve is [the] same. People having knowledge and experience in the same domain can have effective communication to achieve excellent results.	Our team collaboration with Michigan Youth project worked really well, we collected data and feedback from the students and worked on different scenes. So, when the, like as a developer, we know what our end customer needs, then it's really easy to work on and produce something, right? What they can use.
Thomas	I think I am successful . . . [when collaborations are conducted in a] successful manner without any dissatisfaction from any group of people.	[The] project was shaped up very decently based on their feedback toward the experience. So, it's kind of a good collaboration. I felt and they were very supportive in the process of this project.

Multiple Project Impact

Although we did not explicitly ask students to describe their relationships with Maggie and/or the MYP participants, they all conveyed the positive impact they perceived the project had on both the community partner and on themselves, as evidenced by the statements that follow:

- Anna: "I feel that the partner we are working with for this project is, perhaps, much more rewarding and less challenging than most other partners we could have worked with . . . Even an 'I want to be an engineer.' was heard. New experiences were definitely given."
- Milo: "Ultimately, working with the students and Mrs. Maggie was a fun and rewarding experience. I like to think we made a positive impact on their lives and have encouraged them to want to dream big."
- Charles: "Our relationship with the community partner was a fun and joyful relationship in my opinion . . . It was admirable to me to know that there are people that truly want to make a difference in people's lives. Working with the students was also an awesome experience. I enjoyed seeing the students and hanging out with them."
- Joe: "I think we are really lucky to work with those kids . . . This project will definitely impact the students in a positive way to imagine their ideas and work with more innovative thoughts . . . But, overall experience of working with the community partner and my dedication to the project was really good. I have learnt so many new technical things in this project."
- Thomas: "It was a great experience for me when I met those kids at the Pontiac schools . . . and the stories that I heard from them and the approach they [had] towards their community. That felt like a great connection between the groups we have and those kids and the response we got from them and what they wanted to do."

Discussion

In the previous sections, we have described the course design, data collection methods, and study findings based on a graduate-level engineering course focusing on the intersection of VR/AR, user experience, and social justice. In the course, students partnered with a local nonprofit organization to design a historically based VR experience. The purpose of our study was to better understand how the community partner and the graduate students perceive success, what obstacles they think they face, and what characteristics of the community partner they think would be ideal for a VR/AR course, which is a highly technical domain for UX application. In this section, we will discuss our findings by addressing our research questions and connecting these findings with previous research.

How Do Students and Community Partners Perceive Successful or Unsuccessful Collaborations? How Do Their Perceptions Impact Their Experience?

Since this was an exploratory qualitative pilot study on a newly developed graduate-level VR/AR course, our goal was not to measure "success in collaboration" using objective metrics. Instead, we wanted to explore students' and the

community partner's perceptions of success and how that might have impacted their collaborative experience.

Varied Definitions of "Success."

Our findings show that the definition of "success in collaboration" varied across students (as seen in Table 6.2) and the community partner. Since students in this class came from a variety of backgrounds, including interaction design, computer science, and engineering, their differing perspectives on success of a project like this could certainly be influenced by differences in educational background (as seen in Table 6.1). For one student, success is "result-oriented" and meant a technical output, while for some, success was determined by a combination of goals or tasks being accomplished, a deliverable, and satisfaction or support from the community partner. Likewise, Maggie's definitions of success in collaboration included both goals (working toward a common one) and specific personalities from individual collaborators (e.g., open, honest, respectful, easygoing). This resonates with Littlecott and colleagues' (2017) research on how perceptions of success can differ depending on the stakeholder.

"Unsuccessful" Does Not Equal a Negative Experience (and Vice Versa)

While we may traditionally align "unsuccessful collaboration" with a negative experience, that was not necessarily the case here. Even for the student who did not consider the collaborative project to be "successful," he still considered it to be an "awesome" experience because he admired Maggie's passion and enjoyed collaborating with the MYP participants. Similarly, although the community partner did not necessarily receive the deliverable that they were promised (to showcase at the MYP participants' presentation), Maggie still considered the collaboration a success because her definitions highlighted the importance of positive engagement from the stakeholders involved in this collaborative process: the instructor, the graduate students, and the MYP participants. Conversely, students who did consider the collaborative project to be successful still offered strong recommendations for improving the experience (e.g., more technical expertise from the community partner and more time with/feedback from users), which at first glance, may appear to indicate a highly unsuccessful collaboration. This is similar to Butcher and Jeffrey's (2007) findings, which correlated student perceptions of success with the social process of collaboration. In fact, they argued that:

> Much of the voluminous contemporary debate regarding the design and management of collaboration implicitly views the process as something to be engineered, manipulated, and somehow optimized. As a social process . . . the personal experience of research collaboration is necessarily imperfect, noisy, messy, and ultimately one of mixed emotions and outcomes, thereby constraining the impact of interventions based on a 'best model' prescription. (2007, p. 1248)

Mutual Positive Engagement/Relationship

There is a strong impact of mutual trust and good relationships on collaborations (as cited by Butcher & Jeffrey, 2007). When the instructor approached MYP as a potential community partner for her class, she did not foresee the strong effect of a mutual positive relationship between the graduate students and the MYP participants. It was not the explicit goal of the collaborative project to make both parties (graduate students and Maggie/MYP participants) enjoy working with each other. This is especially the case because the graduate students did not enroll to take a "UX in social justice" or a service-learning class, but were primarily interested in learning technical skills to develop VR/AR. Therefore, while Reddick and colleagues (2018) argued that some graduate students' motivation for service is likely based on their previous service engagement and therefore lead to a positive experience, our results suggest that these positive outcomes can be achieved even without the initial motivation to participate in such a course.

From the perspective of the community partner (Maggie's), simply giving the underprivileged MYP participants the opportunity to interact with university graduate students was a success in and of itself. For her, the additional exposure to both people and resources at the university could help MYP participants be more open and excited about future possibilities. Likewise, all graduate students mentioned the intrinsic benefit of interacting with the MYP participants, which resulted in positive outcomes for them (even for the one who did not consider the project a success). To take it even a step further, students might have helped broaden MYP participants' perspective by presenting future career paths and higher education options, and further contributed to their self-worth by taking them seriously and valuing their input.

This "byproduct" compelled us to consider how collaborations can be strengthened by identifying organizations that will have mutual benefit simply from interacting with university students. Further, despite the sudden change in instructional style and course requirements due to COVID-19, both collaborators felt that they had received positive benefit already from the few initial meetings.

What Community Partner Characteristics Affect the Perceived Impact of Collaborations with Graduate Students in VR/AR Courses?

Personalities and Attitudes

Both the students' and community partner's personalities and attitudes can impact collaboration. Based on her previous experience collaborating with undergraduate students on various projects, Maggie found graduate students to be good collaborators because of their maturity, inclusiveness, respect for, and comfortable interactions with the MYP participants. This resonates with Kimme Hea and Wendler Shah's (2016) findings, where community partners "reiterated

a primary motivation for their participation is the enthusiasm and energy that students bring to consultant projects" (p. 62). Similarly, Maggie described the instructor as being open-minded, easy going, flexible, and able to communicate well. These characteristics are important, as open communication was "most often discussed when . . . community partners . . . describe an 'unsuccessful' service-learning collaboration," and this applies to both instructor/student communication in discussing flexibility "when the situation does not proceed according to plan" (Kimme Hea & Wendler Shah, 2016, p. 61). Likewise, graduate students enjoyed working with Maggie and found this collaboration rewarding because of Maggie's easy-going nature and passion for the organization (McEachern, 2001), along with their ability to provide new, exciting, and inspiring experiences for the MYP participants.

Goals and Location

The community partner's location and goals/mission can impact collaboration. As an educational nonprofit organization, Maggie considered educators to be good collaborators because both share similar goals. Having "mutual understanding and appreciation of motivation, interests and needs" (as cited by Butcher & Jeffrey, 2007, p. 1242) is often considered to be an important characteristic of a successful collaboration. Our findings correlate with Kimme Hea and Wendler Shah's (2016), where they found that community partners do not necessarily want students to achieve the "exact same goals" as them—rather, "students who were able to set their own learning objectives were also more likely to foster a satisfying partner-student rapport and in turn create a better product" (p. 62). Furthermore, it is clear from Maggie's responses that she felt MYP participants were more engaged because of their positive VR/AR learning experiences and interactions with the graduate students during those face-to-face meetings. This was enhanced by the close proximity of the university and the MYP.

(Lack of) Technical Expertise

The community partner's technical expertise (or lack thereof) can impact collaboration. Since Maggie and the MYP participants did not possess the technical knowledge and skills that the students thought were crucial for the project, the community partner relied more heavily on the graduate students for their expertise. The project outcome, as evidenced in Maggie's comment, exceeded MYP's expectations and made it a positive experience for them. Similarly, these engineering students are familiar with the problem-solving process, so they recognized the benefits of being able to design the project by defining their own objectives and developing solutions. This additional ownership can be an asset, as it more clearly mimics real-world scenarios in which they, with their graduate degrees in engineering, may be looked to as "experts" on the topic at hand, as pointed out by Riley and Bloomgarden (2006). In those scenarios, they would need to be flexible in making high-level decisions based on constraints and (sometimes) moving

goals. Therefore, a project like this gave them the chance to learn in a safe environment. For example, students initially over-planned and had to recognize their own resource limitations. In doing so, they realized that they needed to scope back the project to complete it on time. Unlike the undergraduate students in Riley and Bloomgarden's (2006) case study, graduate students in this course were able to act flexibly and creatively during their problem-solving process, which could be due to the "maturity" that Maggie described when comparing graduate students and undergraduate students.

What Obstacles Stand in the Way of Productive UX on VR/AR Partnerships? How Can We Work to Overcome These Obstacles?

(Lack-of) Technical Expertise

While the collaboration with MYP was a success by most accounts, it highlighted several obstacles to collaboration. Having "close alignment of expertise and interests of collaborating parties" (as cited by Butcher & Jeffrey, 2007, p. 1242) is considered to be another important characteristic of a successful collaboration. In this case, students found that even though both parties agreed on the deliverable, the technical expertise and experience were not mutually aligned, which is similar to the condition of "mixed skill levels" that McEachern (2001) used to describe nonprofit staff. More specifically, the lack of shared understanding of VR/AR technology made it difficult for students to understand the needs and desires of the MYP participants when they attempted to collect data. To overcome this challenge, students readily adapted their methods, such as by slowing down to have more intentional conversations or switching to observational data collection instead of relying on verbal feedback. Further, the chance to make decisions resulted in more freedom and more accurately reflected real-world scenarios, which may have contributed to a sense of ownership of the final deliverable. In addition, because the community partner had minimal expectations regarding the technical specifications of the deliverable, this meant that the students were more likely to be successful in meeting their expectations.

A potential solution to this challenge is to identify community partners who are not located in close proximity, but who share technical expertise in the topic area. However, a key benefit of this kind of community-based service-learning project is to engage students with the area around their university. While some researchers encourage students to find community partners that align with their own interests (e.g., Nielsen, 2016), finding technical expertise that aligns with the course content and/or student interest may limit the geographical location of community partners. It is unlikely, especially for highly technical VR/AR UX-based courses, to find a community partner that possesses the same technical expertise of the course in the same geographical area. Even in a large geographical area such as the Detroit metropolitan area, the

instructor was unable to locate a nonprofit organization that focuses on social justice issues with VR/AR expertise.

Communication

Another challenge is the lack of structure in the communication and feedback process between students and the community partner (including both Maggie and the MYP participants). Similar to findings from previous researchers (e.g., Butcher & Jeffrey, 2007; Riley & Bloomgarden, 2006; Walsh, 2010), establishing useful communication channels is important but difficult for students. Even when students are encouraged to initiate and create that channel, they may not be prepared or motivated to create their own structure. Perhaps, this type of project stretches students in ways that they are not used to (two students explicitly mentioned in the interviews that this was their first service-learning project experience), and it requires building "soft" or interpersonal skills (e.g., communication, planning, project management) in addition to technical skills. As engineering students, they quickly and easily identified technical expertise as an area that they needed to develop, but may have overlooked these soft or interpersonal skills. Addressing the importance of these additional tasks can reinforce to students that communication and interpersonal skills are critical to the success of collaborations and therefore must be a key part of the plan. Thus, a potential solution is to clearly establish stakeholder roles and expectations for both the students and the community partner early in the semester (Walton, 2007). Instructors can also clearly define expectations for the process to encourage students to adopt best UX practices. By focusing on process expectations, rather than outcomes, students can be encouraged to, for example, communicate more frequently with the community partner. Therefore, framing the process is vital to ensuring the success of the process, which in turn should ensure a satisfactory deliverable at the end of the course.

Time Commitment

Finally, collaborations like this require a significant time commitment from the instructor, students, and community partners. One consistent theme across responses from both students and MYP is that more feedback and interaction is advantageous. One solution would be to connect students to community partners earlier in the semester, as recommended by Murat Tiryakioğlu and colleagues (2009). Even if the students do not yet have the technical knowledge to begin the process, requiring students to establish communication early can help them become more invested and can build the communication channels that are so vital later in the project timeline.

Students in this course were simultaneously full-time employees and students, which likely impacted their ability to devote significant time to the project. For example, much of their work had to be completed over the weekends. Yet, as

COVID-19 drastically changed the interactions toward the end of the semester, all students commented in class that they would like to maintain the connection with MYP, with one student writing in the reflection that he hoped to have the chance to present their final project to the MYP participants after the semester at a later date. Even though this was the students' first time collaborating with a community partner that does not have a long-term sustainable relationship with the department, instructor, or class itself, the perceived impact can be seen.

As Riley and Bloomgarden (2006) pointed out, the reality is that students have to leave at the end of the semester because the engineering curriculum does not typically allow for long-term commitments with students. Graduate students especially are often expected to focus primarily on research/scholarship and professional development (Reddick et al., 2018), which may hinder them from devoting a lot of time to community engagement or service-learning projects. Therefore, a possible solution may be to develop shorter collaborations and smaller partnerships where positive outcomes can be achieved with less time commitments.

Conclusion and Implications

The goal of our study was to explore graduate students' and community partner's perspectives to develop a better understanding of how a graduate-level UX engineering course on VR/AR can impact both stakeholders. Our findings show that there is clearly value for a highly technical course in partnering with organizations with varied levels of expertise as evidenced by the positive experiences of both students and the community partner. Yet ensuring the project is successful requires careful course design (described in more detail in Chapter 7), along with recognition that students and community partners will likely derive different meaning from the experience. We found that the varied definitions of success across students and the community partner resulted in a largely positive experience even when the project did not go as planned. Community partners may derive value from unanticipated sources which are independent of *project* "success," such as the positive value that our community partner felt resulted from interactions between MYP participants and university students. Successful collaborations may extend beyond scope of the planned project, and allowing space for adaptation can foster these benefits to create a more positive experience. Identifying community partners that are not only open to collaboration, but also are open to adapting as the project evolves will support the success of similar projects. Additionally, sharing common goals and close physical proximity further support collaborations. Yet regardless of these factors, when it comes to collaborating within highly technical graduate courses, obstacles such as technical constraints and required time commitment are likely to impact project success. Instructors can mitigate some of these obstacles by providing supporting infrastructure, particularly by clearly communicating both with students and community partners.

Still, it's unlikely that all obstacles will be mitigated because of the complex interactions with multiple stakeholders. While there are many tradeoffs in this type of collaboration, in this case, the benefit gained across all stakeholders seemed to exceed the effort required to build it.

While this is an exploratory qualitative study on a pilot course that is limited to a small sample of participants in a very specific location, our findings contribute to scholarly conversations on productive partnerships in UX in that we offered both the perspectives of graduate students and the community partner. This is our way of answering the call of Kimme Hea & Wendler Shah (2016), who concluded their article by arguing that "we must conduct more technical communication service-learning research to include community partner perspectives" (p. 64).

As Butcher and Jeffrey (2007) aptly put it, "formality provides ambition, focus, efficiency, audit, whilst the informal engenders flexibility and independence. It is perhaps unsurprising that, irrespective of the measure used, some collaborative projects perform poorly" (p. 1248). While engineering projects are often based on formal project management structures, we found that informal elements such as mutual trust and good relationship, personalities or attitudes, technical expertise, goals and location, communication, and time commitment interweave and impact collaboration, sometimes in unexpectedly positive ways.

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