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Metaverse adoption for the teaching and learning of project management: an exploratory study of student use

Alanah Mitchell
Zimpleman College of Business, Drake University
2507 University Ave, Des Moines, IA 50311-4516
USA
alanah.mitchell@drake.edu

Abstract:
The rapid adoption of collaboration technologies over the course of the COVID-19 pandemic, combined with the advancement, growth, and proliferation of metaverse technology capabilities, has created a heightened awareness and comfort with the use of advanced collaboration technologies for online and distance education. This paper presents an exploratory study of how metaverse technologies can be adopted for the teaching and learning of project management concepts and skills specifically, as metaverses have been identified as a legitimate tool for the support of virtual projects. As a part of this work, a task was designed and adopted in an undergraduate project management course. Study results related to the teaching and learning of project management as well as student perceptions of metaverse technology adoption show that students were able to work together in a metaverse environment and collaborate with one another to achieve group consensus on a task. Ultimately, the findings from this case can guide future adoptions of metaverse technologies both in and out of the classroom.

Keywords:
metaverse; collaborative learning tools; project management and collaboration; project management education.

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1. Introduction

Over the course of the COVID-19 pandemic, there was an increased adoption of collaboration technologies both in and outside of the classroom [1], [2], [3]. In the classroom, we saw the rapid adoption of *Zoom*, *Blackboard Collaborate*, and other collaboration technologies to support online learning and other forms of distance education [4], [5]. Outside of the classroom, we saw the adoption of video collaboration tools like *Zoom*, *Microsoft Teams*, and other metaverse technologies for work as well as for socializing and entertainment [2], [6]. For example, *Loom*, a video messaging company, relied on *Active Replica*'s metaverse technology to host their annual company offsite in 2020 instead of gathering everyone together face-to-face [7] and video game based metaverse *Fortnite* held a virtual concert featuring music artist Travis Scott in April 2020 with over 27 million unique players in attendance [8].

The rapid adoption of collaboration technologies over the course of the pandemic, combined with the advancement, growth, and proliferation of metaverse technology capabilities, has created a heightened level of awareness and more comfort with the use of advanced collaboration technologies. Looking ahead, there is a possibility metaverse technologies will drastically impact the way people collaborate and work together. For example, when summarizing the future of technology in December 2021, Bill Gates stated "within the next two or three years, I predict most virtual meetings will move from 2D camera image grids...to the metaverse, a 3D space with digital avatars" [9]. Furthermore, 43% of business executives already have a metaverse strategy in place according to a survey from Protiviti [10].

With the potential for increased adoption and use of metaverse technologies, it is important to explore how metaverse technologies can be used for education [11], [12]. Research has suggested that the metaverse has the potential to transform education as well as many other industries, including e-commerce, gaming, and currency [6], [12], [13]. Moving forward, it is going to be important for faculty to know how to effectively teach in this new environment and for students to know how to work in and be comfortable learning in this space. Therefore, this research explores the adoption of a metaverse environment for the teaching and learning of project management specifically. The topic area of project management is a suitable discipline to explore as metaverse technologies have been recognized as applicable to the support of global, distributed work and project management [14]. In fact, prior research has found evidence that students find the use of technology and web-based projects created using virtual reality as beneficial to the learning experience in a project management course, suggesting this is a suitable case for more exploration [15].

Therefore, the goal of this work is to explore and learn from the adoption and use of a metaverse technology for the teaching and learning of course concepts in a project management class. To address this goal, this research asks three questions:

> (RQ1) Can a task be designed and executed that allows students to work together in a metaverse environment to apply project management class concepts?
>
> (RQ2) Will project management students perceive a sense of presence and collaboration when working together in a metaverse?
>
> (RQ3) Will project management students identify any value from the adoption of a metaverse technology?

To answer these questions, a task was designed and adopted in an undergraduate project management course. This exploratory study presents a course setting and metaverse task design as an example of an innovative application of metaverse use in higher education. Ultimately, the results and findings from this case will guide future adoptions of metaverse technologies both in and out of the classroom.

This paper is organized as follows: The next section presents the background for this research related to metaverse foundations and the application of metaverse technology in education as well as usage in the discipline of project management. The following section presents the research methodology, followed by the results and findings of this work. This research concludes with a discussion, as well as future opportunities for both educators and researchers interested in the adoption of metaverse technologies in education.

2. Background

The background for this research includes a foundational understanding of the metaverse and what metaverse adoption looks like in education in general as well as in the field of project management.

2.1 Metaverse

The metaverse is a network of virtual worlds combining the real world with a virtual world in a seamless way that allows individuals to participate in various life-like activities in a virtual environment [11], [12]. Specifically, a metaverse is defined as "immersive three-dimensional virtual worlds in which people interact as avatars with each other and with software agents, using the metaphor of the real world but without its physical limitations" [16, p. 91].

The term "metaverse" was originally introduced in Neal Stephenson's science fiction novel *Snow Crash* and was used to describe a virtual environment where users interacted as avatars [12], [17]. The term comes from "meta" meaning beyond and "verse" meaning universe [18]. While the topic of metaverses have been studied by researchers and academics in various contexts since then [13], the concept did not gain popularity with the general public until *Facebook* renamed themselves to *Meta* in 2021 [12], [19], [20]. Some predictions suggest the metaverse will become the successor to the internet [11], [12].

One model for research in metaverses identified five key components of interest: 1) the metaverse itself, 2) people and avatars, including concepts of representation, presence, and immersion, 3) metaverse technology capabilities for the support of communication, interaction, and team processes, 4) behaviors such as coordination, shared understanding, and trust, and 5) virtual world outcomes including concepts such as intent to immerse and perceived quality [16]. The decentralized network infrastructure and environment persistence are other important concepts often included in understanding metaverse technology [6], [20].

2.2 Education in the Metaverse

Various theories of learning have developed over time, including the objectivist model, the constructivist model, the cognitive information processing model, the socio-cultural model, and the cooperative or collaborative model [21]. Each of these models vary in many aspects. For example, the objectivist model presents a traditional approach to learning where the teacher passes on information and knowledge to students, while some of the other models, including the constructivist and cooperative models, are more learner focused, proposing students can benefit more from independent or collaborative information discovery [21]. When exploring the adoption of a metaverse environment for teaching and learning, it seems that a student focused learning theory might present an opportunity. In fact, prior research has even suggested that 3D learning environments and environments that support the bundling of various technology capabilities allowing for collaboration, feedback, and student interaction (e.g., multimodal communication tools) are suitable tools for supporting collaborative learning [5].

Cooperative or collaborative models of learning have been used in education in a number of different ways. For example, active learning is a type of collaborative model that focuses on the engagement of students both thinking about and doing things in a learning environment [22]. This type of learning tool has been found by research to be a useful predictor of student success [23]. Another experiential practice in the classroom, referred to as Kolb's learning cycle, specifically asks students to create knowledge through a process of experiential transformation following a four-stage learning cycle that includes abstract conceptualization, active experimentation, concrete experiences, and reflective observation [24]. In a virtual environment, this cycle might ask students to learn through the exploration of concepts, planning for and having an experience, and reflecting on any lessons learned.

As a metaverse environment is an online environment, some of the challenges of online or distance learning may be relevant in this space. For example, online or distance learning challenges suggest students and faculty report a lower sense of engagement, presence, or place, and may report the overall sense of community as lacking [5]. Research suggests when an instructor can create a sense of presence in an online context, increased student engagement and satisfaction with a course and instructor can be achieved [5]. This opportunity is important to emphasize. While leaners

may be resistant to turning on their cameras in a video collaboration environment, this would not necessarily be an issue in a virtual world as learners would interact using avatars. Relatedly, prior work recognizes the value of increased student engagement and teamwork in the classroom as a way to prepare students for their future workplaces [25].

Surveys exploring the teaching and learning of virtual collaboration and the adoption of metaverse technology have revealed that not many faculty are using metaverse as a tool for teaching and learning [26], [27], [28]. In fact, a couple of recent surveys reported zero faculty using metaverse technologies for teaching and learning [27], [28]. One contributing factor to this finding may be that the field of education is often considered to be resistant to change [29], however, the domain of digital learning is consistently working to innovate and transform [12]. One systematic review of metaverse education research found that the first study of metaverse education research was published in 2007, with a sharp decline in interest in 2013, and interest returning in 2020 [20].

Overall, researchers have studied metaverse usage in various educational settings including K-12, higher education, and corporate training [12]. For example, one study in higher education used *Minecraft Education* as a tool for teaching Agile concepts, making the case for simulation based learning [30]. Another study in higher education used an open source metaverse environment to bring together interdisciplinary groups of students to collaborate on class projects [31]. A third study exploring metaverse use for corporate training found employees trained in virtual simulations learned faster than classroom learners [32]. In general, these studies have all been supportive of the metaverse as a tool for teaching and learning. Yet, the need for more guidance and best practices remains.

Finally, studies of gamification in education may be relevant to metaverse education research as the environment can be considered game-like. Some studies of gamification suggest these types of techniques can stimulate engagement and deeper learning as students are able to choose their own focus and pace themselves while working through learning exercises [33], [34].

2.3 Project Management in the Metaverse

As mentioned above, metaverse applications have been studied in a number of different contexts [13]. One area of study has been related to virtual world projects. A project is defined as a "temporary endeavor undertaken to create a unique product, service, or result" [35, p. 4]. The goal of project management is to manage the intensive and complex requirements of a project, by employing methods and tools, in order to achieve project success [15], [36]. Project management happens to be a key area of study in relation to metaverse research. In fact, research has found that "virtual worlds have gained legitimacy in business and educational settings for their application in globally distributed work, project management, online learning, and real-time simulation" [14, p. 810]. Furthermore, research has posited that the 3D nature of metaverse technology has much to offer project managers in the managing of large projects [36]. One study illustrated this idea through the development of a project and project plans in the construction of a state in a virtual world to educate and inform individuals about the economic and educational opportunities within the physical state or region [37]. Another study of metaverse project management explored how technology capabilities in a metaverse could contribute to project execution and found a notable benefit of the unique environment emerged through the interplay of social behaviors and technology capabilities, suggesting value in the use of the metaverse for projects [38].

In relation to project management education, research has made the case that it is important for higher education institutions to prepare project management graduates to be ready to work in the current complex field of project management [39], [40], [41], [42]. Education in this area is encouraged by the AIS, ACM, and IEEE and should emphasize both theoretical and practical methods and principles [43], [44]. Project managers need to be prepared with a diverse set of skills including communication, leadership, technical and managerial competencies, and resiliency to manage uncertainty [45], [46]. To address this need, a course in project management is often included in higher education curriculum for students at all levels [47], [48]. In these courses, students are often encouraged to work collaboratively in project teams as well as tasked to learn about project management tools and technologies such as *Microsoft Project*, *Jira*, and various collaboration technologies that can be used to support project collaborations and reflecting on these experiences [40], [48], [49]. Relevant collaboration technologies might include email, video

conferencing tools, and even virtual worlds [50] and research has even called for elective coursework to address the use of metaverse tools [51]. Research has found evidence that students value the use of technology and web-based projects created using virtual reality as beneficial to the learning experience in a project management course [15], [52]. This research highlights the importance of technology that supports collaboration among learners, which a metaverse would allow for [15]. Indeed, one early study even used *SecondLife* as a metaverse environment for the teaching and learning of project management [53].

Certainly, the advances in metaverse technologies combined with the increased interest in metaverses will require more faculty to have experience with this type of environment as these tools are used for virtual projects and project management in particular. Therefore, this research seeks to explore if this is possible and if there is a way to design educational experiences that can allow for the teaching and learning of course concepts, specifically in relation to project management, in a virtual world. The following section outlines the details from this case.

3. Research Methodology

This research study looks at the adoption of metaverse technologies for the teaching and learning of project management concepts. The following sections outline the research setting and participants used for this study, the design of the metaverse task, and the data collection and analysis.

3.1 Research Setting and Participants

This study was conducted in an undergraduate level course on project management in Fall 2022. The sample was comprised of twelve students who were split into three teams of four students. Among the participants, six students were male (50%) and six students were female (50%). All but one of the students were college seniors; the one remaining student was a junior. Student areas of study included computer science (17%), data analytics (33%), information systems (25%), or other areas of business (e.g., management, finance) (25%).

As a part of this course, students were studying project management tools and technologies such as *Microsoft Project*, but also collaboration technologies like email, video conferencing, and potentially virtual worlds. As a part of the study of collaboration technologies in this course, an exploration of metaverse technologies and the adoption of the virtual world capabilities for team collaboration was included. Specifically, *Gather* (https://app.gather.town/), a virtual office metaverse launched in 2020, with millions of visitors since then, was selected as the metaverse technology for this exploration.

3.2 Metaverse Task Design

In order to explore the adoption of metaverse technologies for the teaching and learning of project management, students were asked to meet all together in the virtual world (note: this class was primarily a face-to-face class, and the online meeting required a change in modality). The specific areas of focus for this class meeting were communication, team communication, how to enhance team communications, and collaboration technologies that are available for team communication. The class began in the virtual space by meeting as a large group to discuss these foundational concepts (see Figure 1).

Following 20 minutes of background, the students were asked to break into teams and connect with their group in *Gather*. Each team was asked to assume the role of organizational leaders making a decision about the primary collaboration technology to be adopted in their organization. As a part of this discussion, each team member was given a different fact to consider. For example, one team member was told that a calendar feature was a requirement. Another team member was told that video conferencing was not a requirement for the tool but would be an acceptable feature to have. Team members received direct chat messages from the course instructor with these individual requirements. Groups were asked to come to a consensus for their final recommendation and prepare to share and reflect on this task.

Once the task was assigned, students were free to move about the space with their teams to work on their task (see Figure 2). Teams worked together in the virtual world for the remainder of the class as the instructor walked around from group to group to check in.

Fig. 1. Class meeting all together for initial background and instruction

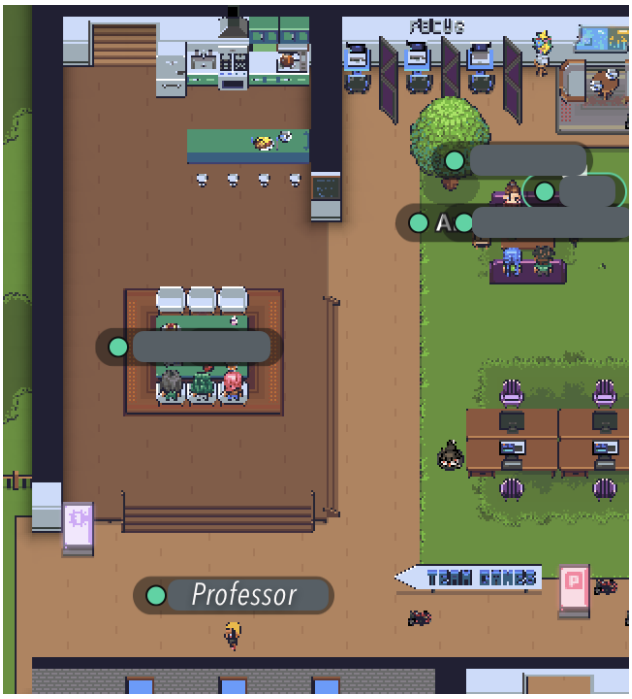

Fig. 2. Team breakout groups with Professor roaming; Team 1 sitting at a table on the deck; Team 2 sitting at a table in the top left grassy area; Team 3 in another area

3.3 Data Collection and Analysis

Upon completion of the task, student feedback was gathered through an electronic survey. Students were asked questions about both the project management task and the technology. Task questions asked students to consider:

1. What collaboration technology did your project management team decide on? Why?
2. Was your project management team able to share information in *Gather*? How so?
3. Did your team make a decision before everyone had shared their individual information? Why or why not?
4. Were you happy with the final collaboration technology that your team selected? Why or why not?
5. Brainstorm three tips for a project manager considering meeting with their team in a metaverse environment.

Technology questions asked students:

6. How strong was your sense of presence (or being there) in *Gather*? (1=not at all; 5=to a great extent)
7. Do you think *Gather* is a useful way to work with other individuals? Why or why not?
8. What technology capabilities did you use in this exercise? What technology capabilities did you not use that you think would have been helpful to have access to?

9. Describe the most positive aspects of the experience you just had? The most negative?
10. Would you recommend using a virtual world for your project management class in the future? Why or why not?

The data captured from this survey was used in evaluation of the findings. As a part of the analysis of the survey findings, open coding was used to look for similarities and differences among the student comments and group the comments into categories [54].

4. Results and Findings

This section presents the findings from this study exploring the use of metaverse technology for the teaching and learning of project management. The following subsections present the research findings related to the teaching and learning of project management and related course concepts as well as student perceptions of metaverse presence and the value of adopting virtual world technologies.

4.1 Teaching and Learning of Project Management

The first research question from this study asks: *can a task be designed and executed that allows project management students to work together in a metaverse environment to apply class concepts?* To address this question a collaborative task was designed that asked students to meet in a virtual world, work through a task where each team member was given a different piece of information, come to a group consensus, and reflect on this experience. Upon completion of the task, students reported that they were able to collaboratively work on the task at hand, share information, reach consensus, and make recommendations for future project managers thus illustrating the application of course concepts.

As outlined above, each team was tasked to assume the role of organizational leaders looking to decide on the primary collaboration technology to be adopted in their organization. Team members were all given different facts to consider in this discussion and were asked to come to a group consensus for their final recommendation. As a part of this exercise, each of the teams selected *Microsoft Teams* as their collaboration technology of choice that would support organizational communication. Student teams reported familiarity with *Microsoft Teams* and determined that it was a match with the each of the individual requirements they were provided. For example, one student summarized their decision by stating:

> "*We decided on Teams since it met all of the requirements we each individually had while we were discussing which platform to pick.*" [P8]

Along with unanimous consensus of the final technology choice, the students also reported unanimous consensus related to their ability to share information with their team members when using *Gather*. For example, one student commented:

> "*Yes, we were able to sit down at a meeting table and have a private conversation about our technology. The chat was also helpful in being able to ask questions in and outside of our group*." [P1]

All of the teams reported that they waited for all of the individual team member information to be shared before they decided on a final technology choice. However, some teams did mention that they brainstormed options throughout their discussion. For example, one student stated:

> "*We gave some suggestions that fit as we went along sharing our information, but we did not decide anything solid until after sharing all of the information*." [P10]

In relation to the metaverse task students were asked to work on, all of the participants reported they were happy with their overall team choice. For example, when asked about their satisfaction with the final collaboration technology selected by their team, one student concluded:

> "*Yes, we all collectively agreed with MS Teams as it was one of the only communication tools we knew that checked off all the requirements*." [P5]

Finally, students were asked to apply the concepts of project management by developing some recommendations and tips for project managers considering meeting with their team in a metaverse environment. Students were indeed able to make some helpful recommendations based on the concepts taught and applied as a part of this metaverse experience. When considering the student recommendations, a few key categories emerged in relation to technology training, meeting practices, task technology fit, and participant motivation. Table 1 is included, summarizing specific student recommendations in each of these areas. A review of the student comments illustrates a clear application of course concepts and overall student learning.

Table 1. Metaverse recommendations for project managers

Category	Student Recommendations (Excerpts)
Technology Training	"*Make sure that everyone knows what the metaverse is and how it works*." [P2] "*Be familiar with the features of the online collaboration space so you know what options are available for use. Many of the platforms have cool features that can go unnoticed*." [P3] "*Training!! Using a new tool can be challenging, especially when there are a lot of features involved*." [P10] "*Establish a backup plan- technology can be unreliable sometimes. Even if your internet is working, some other members might run into problems*." [P3]
Meeting Practices	"*Having an agenda of some kind to help the meeting run smoothly*." [P8] "*Use the chat function to clearly send the main questions or topics so people are able to look over them at any time*." [P11] "*Be responsive once in the metaverse since it is harder to meet when you don't see the persons face*." [P12] "*Having more breakout group activities to get everyone talking*." [P6]
Task Technology Fit	"*Know the audience of your meeting and whether or not this would be something they would like and be interested in because it is more of an informal environment*." [P1] "*Make sure that the metaverse would enhance the meeting*." [P2] "*Consider the number of people who are on your team and whether everyone can fit 'comfortably.' If you are going to have a team meeting with upwards of 25-20 people, I would not suggest this kind of environment because I think it would be too distracting*." [P1] "*If you want people to collaborate in small groups maybe assign groups a meeting space so that they can find each other easily*." [P2]
Participant Motivation	"*Making sure all team members are having input in the discussion and conversation*." [P8] "*Incorporate hands on activities or tasks to encourage engagement. It is hard leading a meeting online especially if nobody has their camera or microphone on*."[P3] "*Maybe a competition to get people into it*." [P6] "*It brings out people's personalities when finding new buttons to hit (ex: the key 'f' threw confetti)*." [P9]

4.2 Student Perceptions of Metaverse Technology Adoption

The second and third research questions from this study are both related to student perceptions. The second research questions asks: *will project management students perceive a sense of presence and collaboration when working together in a metaverse?* To address this question, students were specifically asked about their sense of presence in *Gather*. This question is important as research has suggested when an instructor can create a sense of presence in an online context, increased student engagement and satisfaction with a course and instructor can be achieved [5]. When asked about the feeling of presence in the virtual environment, students reported an average of 4.08 (of 5) suggesting they felt somewhat present in the virtual learning space.

The third research question in this study asks: *will project management students identify any value from the adoption of a metaverse technology?* To address this question, students were asked to reflect on their experience with the virtual environment. In the review of these findings, there were clear student comments suggesting students enjoyed meeting in

Gather. In fact, some student comments showed this tool to be a useful way for creating engagement with the class and class topis. For example, one student commented:

> "*I think this is a great tool because it is more engaging than a Zoom call. You definitely could only use it for a more informal meeting in my opinion because it is a very laid-back setting. I like how I am able to move around too and if I wanted to get an opinion on another group I am able to go into that room and ask them without having to be put in a breakroom by the administrator*." [P1]

The concept of movement in the space and the technology capability supporting individuals walking around was a popular response. Another student stated:

> "*It makes going into "breakout" groups much easier as you do not have to be placed in a room you can just walk around the map and meet with different people*." [P6]

Students also liked that everyone could meet back together after having a breakout team interaction. For example, one student commented:

> "A*t first I was a little confused as to how we would be able to break up in our teams but once I noticed that by allowing teams to venture and sit in different areas it would create its own private room. Which is a great collaboration feature if there are many teams working on a project. Since at the end of the meeting they could all gather together in a main room*." [P7]

Another metaverse capability the students liked was the technology capability allowing for proximity voice and text chat, which is a realistic experience people have. In fact, a few students liked the feature where they could hear team members within their area, with one student stating:

> *"I think it is a unique experience and I really like the feature of having a proximity chat feature where only the members in a certain area of the map can hear you. That way you are free to join other group conversation without hearing all of them at once*." [P8]

Finally, other students found the experience to be a "fun" option for class. For example, one student commented:

> "*Yes, I think that's a great way to work with other individuals because you could get a lot of work done and it's a fun way to work with individuals*." [P4]

Along with the positive feedback, there were some comments that suggested *Gather* would not be a student's first choice of collaboration tools. For instance, one student found the metaverse environment to be difficult to navigate and not very professional, stating:

> "*I think that it would work for some types of meetings but I would not recommend it for just a regular group meeting. The chat function is confusing and hard to navigate. The video chat is glitchy. You can easily accidentally walk out of meetings. It does not feel very professional. It's hard to scroll around the environment and look at your surroundings.*" [P2]

Other students echoed the lack of professionalism in a metaverse, suggesting that the metaverse is too much like a game. For example, one student commented:

> "*Gather is fine, however I feel more professional communication tools work better than Gather. This feels like I am playing Pokémon.*" [P5]

The gaming capabilities in the metaverse environment were not all perceived as negative. In fact, one student both liked and disliked the overall space. This student commented on both the pros and cons of the metaverse capabilities stating:

> "*Yes- it was fun to do other things in the environment like the Go-karts or play a game. No- it was awkward at times when our team wasn't talking or we would all leave to explore an area and then come back to talk.*" [P9]

As a part of the team collaboration and task work, most of the teams reported communicating through the use of video chat, voice chat, and text chat. Some students identified a number of other technology capabilities that were not utilized

but mentioned might have been useful. For example, students commented that screensharing, whiteboard features, mini games for team building, or even calendar features would have been nice to use. Some of these students noted that while they did have access to these capabilities, they did not use them.

Student reflection on the overall experiences resulted in both positive and negative comments. Positive comments were related to the technology capabilities that supported communication, flexibility or freedom in the space, group work, and entertainment offered by the tool. Table 2 specifically highlights some of the student comments related to the positive aspects of using a metaverse environment for class and teamwork.

Table 2. Positive student comments

No	Student Comments (Excerpts)
1	"*The freedom of moving around and joining the conversations you want to join*." [P1]
2	"*We were able to chat in just our groups very easily*." [P2]
3	"*Since we could all communicate through voice chat, the decision resulted from a quick conversation rather than a long email chain or different form of collaboration*." [P3]
4	"*Siloed voice room; location accessibility (being at home is comfortable)*." [P5]
5	"*It makes going into breakout rooms very easy*." [P6]
6	"*Easy to access for one and many users*." [P7]
7	"*Using the proximity chat; Being able to explore the map to join other group discussion; audio/video conferencing tools*." [P8]
8	"*It was fun to explore the space and change what we wore as a character*." [P9]
9	"*It was fun being able to mess with the tool after we had our discussion. I also got to try a new tool*." [P10]
10	"*I liked having the class meeting within Gather. It was nice that we could move around and talk with the team members*." [P11]
11	"*It is really entertaining seeing everyone in their avatars in the virtual world. It is a different way to interact than our usual classroom setting*." [P12]

Negative comments were related to the technology capabilities that allowed for navigation of the space, technology challenges, and distractions offered by the tool. Table 3 specifically highlights some of the student comments related to the negative aspects of using a metaverse environment for class and teamwork.

Table 3. Negative student comments

No	Student Comments (Excerpts)
1	"*There aren't really meeting areas with names so it took me a little bit to find my group but not long*." [P1]
2	"*The video chat kept going in and out and the chat was hard to navigate, especially one on one chat*." [P2]
3	"*It makes to harder and slower to go visit each group [in breakout groups]*." [P6]
4	"*Gather could maybe be distracting because of all the features it has with the map and such*." [P8]
5	"*It felt like Zoom or Microsoft Teams*." [P9]

No	Student Comments (Excerpts)
6	"*If you moved out of a space you were disconnected from voice chat*." [P10]
7	"*I did not like when I logged in the avatar was stuck outside of the building and I wasn't able to join the group until I spent time trying to get in*." [P11]
8	"*It was hard to navigate around the set up, my initial log in I was outside the building and couldn't get into the classroom so I had to log out and log back in*." [P12]

As a final point of reflection, the participants in this study were asked whether or not they recommended that future classes be held in a virtual world. Interestingly, 58% of the students were interested in this idea. Some of these comments were related to how engaging the virtual environment was. For example, one student commented:

> "*I personally felt more engaged. I was able to visualize the classroom without being there and to me, that is super helpful*." [P1]

Students also valued the metaverse as an option for class when other variables would impact the safety of a face-to-face meeting. One student stated:

> "*Yes! If the group can meet safely in person, I think that is best. However, this offers a great alternative because of the features I mentioned above. Many aspects of a classroom can be replicated and members of the class can still collaborate well in a virtual environment*." [P3]

The idea that the metaverse environment offered a close comparison to the physical classroom came up in multiple comments. For example, another student noted:

> "*Yes, I think this would help make the virtual class more realistic. it is still interactive much like a classroom*." [P11]

The students participating in this study have experienced quite a bit of online education over the course of the COVID-19 pandemic and the insights from students with this experience are certainly well-informed. One student noted this as a part of their reflection, stating:

> "*As someone who spent half of their college career online and in a virtual world, I would recommend a virtual class as it is more interactive than just sitting and watch a lecture or staring at someone talking.*" [P5]

Some of the student comments noted that educational experiences in the metaverse would be helpful preparation for future professional experiences. For example, one student commented:

> "*Yes, I would it is necessary to be able to meet in environments like this to get people ready for what some professional experiences will be like*." [P6]

Finally, the entertaining and engaging aspects of the metaverse were identified by students as a motivating reason for metaverse adoption in education. One student noted:

> "*It provides a different, fun way of communication. We have a character we can customize, can move to different spaces, can react to what each other is saying with emotes, and more*." [P10]

While 58% of the student comments specifically recommended the metaverse be used for teaching and learning, 25% of the participants noted that metaverses should be used, but sparingly. These students recommended using a virtual world for class a couple of times per semester. For example, one student commented:

> "*I would only recommend this as a 1 or 2 times thing for class. This because I think a virtual world is pretty cool to use for class, but it could get very distracting at some point for some students*." [P8]

Another student agreed that learning new technologies is valuable but should not be a regular thing, stating:

> "*Yes, but not consistently. It is always good to try new things to keep it interesting.*" [P12]

Finally, comments about the suitability of the technology were noted. In fact, one student thought the metaverse might work for some tasks, specifically posters, but not for regular class meetings. This student noted a preference for *Zoom* or *Microsoft Teams* stating:

> "*I think it would work for a poster session but for regular class meetings it seems unnecessary. You can do all of the same things in Zoom and Teams.*" [P2]

When asked about metaverse adoption, only one student was not interested in recommending metaverse technologies for teaching and learning. This student summarized their recommendation by stating:

> "*Though it was fun to see what a virtual world could be for a classroom, it would not be as affected for learning since the communication was little.*" [P9]

The feedback from students in this case clearly show the vast majority of participants in this study thought the metaverse should be adopted and used at least sometimes as a part of a student education.

5. Conclusion and future work

This paper explored whether or not there was a way to design an educational experience that could allow for the teaching and learning of course concepts in a virtual world, specifically in relation to project management. A case was presented including the specific task design, process, and student outcomes as well as students' perceptions about the adoption of a metaverse environment as a part of the learning process. The findings from this case suggest that project management students were able to work together in a metaverse environment and collaborate with one another to achieve group consensus on a task. Students were able to reflect on the experience and relate it to the topic of the course as well as reflect on their own perceptions of the experience. Table 4 summarizes both the research questions and findings from this study.

Table 4. Research Questions and Findings

Question	Findings
RQ1 Can a task be designed and executed that allows project management students to work together in a metaverse environment to apply class concepts?	• A collaborative task was designed asking students to meet in a virtual world, work through a task with different information, come to consensus, and reflect • Upon completion of the task, students reported they were able to collaboratively work on the task, share information, reach consensus, and make recommendations for future project managers thus illustrating the application of project management course concepts • Participants reported unanimous consensus regarding their ability to share information with their team members when using the metaverse environment *Gather*
RQ2 Will project management students perceive a sense of presence and collaboration when working together in a metaverse?	• When asked about their feelings of presence, students reported an average of 4.08/5 suggesting they felt somewhat present in the virtual learning space
RQ3 Will project management students identify any value from the adoption of a metaverse technology?	• Student comments suggested they enjoyed meeting in *Gather* and appreciated the engagement, movement, and interaction with the tool • Students expressed some concerns about the game-like features of the tool and lack of professionalism • Overall, 58% of the students were interested holding future classes in the virtual world

The contributions of this work are several. First, a task, the technology, and teaching process is presented for the teaching of project management concepts in a virtual world. Second, tips for future project managers are included as the outcome of the student work (see Table 1). Student perceptions and recommendations related to metaverse presence and

the use of collaboration technologies for projects are also presented. Finally, this research provides support of the adoption and use of metaverse for the teaching and learning of project management as students in this project were overall satisfied with the technology usage as a possible learning tool.

The limitations of this work present additional opportunities for educators and researchers. First of all, the number of participants in this study was small and may be considered exploratory. However, prior research has concluded qualitative research with twelve participants is enough to reach data saturation [55]. It is also important to note that the class, the instructor, and the teams, had established relationships prior to having this experience. This class exercise took place following the semester midterm, so each of the groups had already spent time working together. Therefore, in this case, the teams and the instructor had already established relationships and this experience might not have been as successful if teams were brought together to work in the metaverse without the foundational relationships formed prior to the virtual experience. Future research should explore metaverse adoption in larger class sizes and more random team pairing to determine what type of impact these factors may have. It is also important to note that the participants in this case were students from an undergraduate-level course on project management, and they may have different characteristics from the general population.

As with most digital learning innovations, technical issues are a potential challenge. In this study, the faculty member did have to change the administrative settings of the browser to be able to share the instructor screen. This last-minute challenge took away from some of class time. In fact, one student commented on this issue as a negative: "*the professor needing to leave and join the room to use the screen sharing feature*" [P7]. However, it is important to note that there were not any student technical challenges with the technology reported in this case. In an effort to catch any possible issues ahead of time, the class did log into the virtual classroom in advance of the virtual class meeting time, just to make sure everything would work when the time came. Of course, faculty should always prepare for these types of issue and perhaps have a backup plan in place (e.g., *Zoom*, or a university supported virtual meeting tool). Relatedly, the technology choice in this study is also a limitation as *Gather* is only one example of a metaverse technology with unique technology capabilities that are not representative of all metaverse technologies.

One of the research questions in this study specifically explored the student perceptions of presence and found that students did feel somewhat present in the metaverse. This question is especially important due to the impact of presence on course engagement and satisfaction from students [5]. While it seems like the findings in this case were valuable, it would be interesting to compare the sense of presence when in a *Zoom* meeting or another collaboration tool to a virtual world meeting, especially when considering the lack of cameras on when teaching in many virtual collaboration platforms [5].

Finally, while the task from this study was specifically related to the discipline of project management, future work might consider applying this type of collaborative task in other classes. For example, teams could be asked to collaborate on other topics, e.g., given a task to identify a solution, challenges, or opportunities, with individual students provided with unique requirements that would need to be shared so that collaboration in the metaverse is essential to the task. As more educators begin to experiment with metaverse technologies for teaching and learning, more support for the technology, lessons learned, and best practices will emerge.

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Biographical notes

Alanah Mitchell

Alanah Mitchell is Aliber Distinguished Professor of Information Systems and Associate Dean of Academic Affairs in the Zimpleman College of Business at Drake University. Professor Mitchell's research focuses on the design, implementation, and use of information and communication technologies for collaboration, specifically in global virtual teams. Additionally, she researches in areas of e-commerce and information systems pedagogy. She has published in such journals as *Communications of the Association for Information Systems*, *DATA BASE for Advances in Information Systems*, *Information Technology and People*, *Journal of the Association for Information Systems*, and *Organizational Dynamics* as well as others.