

School-Based Agricultural Education Teachers' Lived Experience of Integrating Virtual Reality into their Classroom

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Abstract

Agricultural Education uses a combination of classroom and laboratory instruction, experiential learning, and leadership education to prepare students for jobs in industry. With the recent promotion of Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) as an option for educational programs, this technology allows teachers to incorporate experiential learning and give students real experiences when they otherwise might not have the opportunity. VR has been used across many industries, such as medicine, construction, manufacturing, military training programs, and tractor and machinery operation, as a form of training. The purpose of this qualitative study was to explore Ohio SBAE teachers' lived experiences of incorporating a VR experience and technology into their curriculum. Eleven teachers participated in semi-structured interviews to describe their lived experiences. Three themes and 11 sub-themes emerged from those results. Participants described their experience as one that provided valuable benefits, introduced new challenges, and a semi-realistic interpretation of a hands-on activity. VR can be successfully integrated into skill-based instruction by ensuring teachers and students have positive user experiences, addressing students' performance, and providing a realistic interpretation of a hands-on activity.

Introduction and Literature Review

“Workforce education and development is the key to promoting individual learning and skill training” (O’Lawrence, 2017, p. 6). Since the early 19th century, workforce education has strived to produce workers with hands-on skills necessary for certain trades through individual learning experiences and classroom instruction (ACTE, 2022). Career and Technical Education (CTE) is a major component of workforce education in public schools, which evolved from various bills such as the Smith-Hughes Act giving rise to Agricultural Education programs (ACTE, 2022). Career and Technical Education provides the connection for students between secondary and post-secondary learning and acquisition of skills for their later careers (Adamuti-Trache et al., 2020; Stone, 2013).

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School-Based Agricultural Education (SBAE), one of the fields in CTE, uses a combination of classroom and laboratory instruction, experiential learning, and leadership education to prepare students for jobs in the agriculture industry (NAAE, 2022). Experiential learning is a common educational practice employed throughout agricultural education (Coleman et al., 2021; Roberts & Ball, 2009; Shoulders & Myers, 2013). Through a synthesis of the literature, Roberts (2006, p. 26) defined experiential learning “as a process or by the context in which it occurs.” His model of Experiential Learning Contexts explained experiential learning could occur across four dimensions: the level, duration, intended outcome, and the setting (Roberts, 2006). Virtual Reality (VR) can be introduced in the learning environment to provide an alternative and unique setting for experiential learning by immersing users in the content (Pellas et al., 2021).

The foundation of VR, and its associated technologies, Augmented Reality (AR) and Mixed Reality (MR), are all based on “a three-dimensional, computer-generated environment which can be explored and interacted with by a person” (Virtual Reality Society, 2017, p. 5). Virtual reality uses a fully immersive environment and technology to engage the user in the experience. Augmented reality is the least immersive of the three and uses technology such as a smartphone to overlay an environment that can be interacted with through the phone. Mixed reality is a mixture of the other realities; it allows the user to interact with accurate equipment in an immersive environment, such as a driving simulator.

These technologies are options for teachers who wish to incorporate experiential learning and give students real experiences who otherwise might not have the opportunity. Johnson (2010, p. 22) stated, “AR has strong potential to provide both powerful contextual, on-site learning experiences and serendipitous exploration and discovery of the connected nature of information in the real world.” Lamb and Etopio (2019) found a preservice teacher experience promoted learning from modeled real-life situations for the transfer of theory into practice. In another study, students were immersed in a virtual learning environment before the start of an online literacy course. Through their experience, students reported positive perceptions and valued the use of the virtual environment (Domingo & Bradley, 2018). Liarokapis et al. (2004) demonstrated AR can make complicated mechanisms and difficult theories in higher education accepted and understood by students. Positive experiences and applications have been reported in several educational settings, paving the way for VR to enter other disciplines as a training method.

VR has been used across many industries as a form of training, such as medicine, pedestrian safety, construction, manufacturing, military training programs, and preservice teacher preparation. For example, experienced surgeons who had prior experience with VR training were significantly faster and used significantly less contrast fluid than the inexperienced group (Aggarwal et al., 2006). Another training program used in the construction industry reported workers showed a significant difference between pre and post-tests in hazard ID and prevention (Sacks et al., 2013). The mining industry has tested VR, primarily around safety practices, in attempts to reduce the number of injuries that happen on the job. As a result, a range of equipment simulators including dozers, draglines, haul trucks, shovels, and continuous miners are available commercially (Tichon & Burgess-Limerick, 2011). With the use of VR across multiple industries, the need for accurate and realistic experiences has become the main concern.

When an experience is not sufficiently realistic, it can detract from the students' ability to learn. Kavanagh et al. (2017) found in a synthesis of research, 20% of the studies analyzed reported issues related to VR systems providing an insufficiently realistic experience. This accounted for 26.9% of the total output problems reported (Kavanagh et al., 2017). Other studies reported users of the VR systems found their implementations to be insufficiently realistic, and authors worried this may detract from the learning experience (Huang et al., 2010; Lee et al., 2010). Other studies found a connection between presence and realism, to the point when users were not familiar with the technology it affected their sense of presence and created an unrealistic experience (Gisbergen et al., 2019; Lombard & Ditton, 1997). Schwaab et al. (2011), for example, designed a VR system to simulate mock medical emergency oral examinations. While

most of the students reported they preferred the VR system to the traditional approach, several also claimed it did not really reflect their practical experience and would therefore provide limited benefit to their learning, even though one safety education-based study showed 3D VR was more effective than a lecture-only delivery method and equally comparable to a lecture with a physical laboratory (Nakayama, 2014). In addition to limitations to the realism provided by the virtual environments, visual and graphic limitations to the devices can exist providing low pixel density, image latency, and other limiting sensory factors (Cuccurullo et al., 2010; Hsiao et al., 2010; Shafer et al., 2019).

Additionally, VR curricula allow students to experience potentially hazardous and stressful situations within a safer environment. As previously noted, VR has widespread application to technical training programs, including machinery operation. Allowing students to engage with these situations in a realistic and safe environment can allow students to learn the necessary skills to be successful with the real experience. Currently, the use of VR in agricultural education has been focused on VR welding experiences and trainings. Wells and Miller (2022) found students in an agricultural mechanics course experienced alignment between the VR welding system and live welding, and that it had utility as tool for teaching and learning. In a separate study, Wells and Miller (2020) found a VR welding training neither improved or detracted from students' weld scores. In another study, VR welding has shown in some cases students in a VR integrated welding group outperformed the traditional welding groups (Stone et al., 2011). VR welding has begun to pave the way for other VR applications to be used within agricultural education.

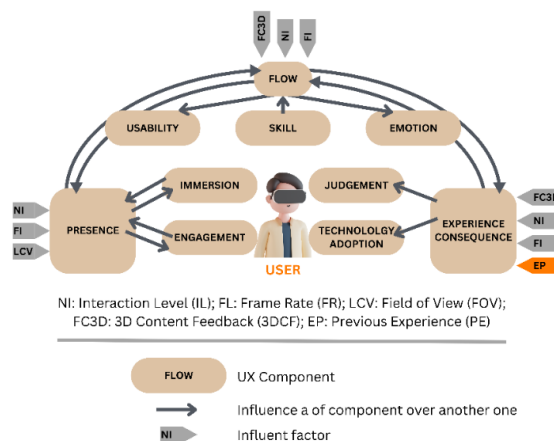
If the purpose of a workforce development program is to provide students with realistic experiences to prepare them for jobs in industry, then virtual reality has the potential to benefit CTE. Wells and Miller (2020) found SBAE teachers held favorable opinions toward VR but were uncertain regarding its use. Making these experiences as realistic as possible, VR can be used in wider training applications, including the various content areas of agricultural education. However, a lack of literature exists exploring VR based learning experiences in CTE and agricultural education. This study begins to address the gap of literature regarding the integration of VR into Agricultural Education.

Theoretical Framework

The theoretical framework chosen for this study is the user experience (UX) model developed by Tcha-Tokey et al. (2016). This framework helped us contextualize teachers' experiences by guiding the interview questions to allow their lived experiences emerge through the lens of user experience. The components of this model are Presence, Immersion, Engagement, Flow, Usability, Skill, Emotion, Judgement, Technology Adoption, and Experience Consequence, as shown in Figure 1.

Figure 1

User Experience Framework



Presence, also used as a construct, is a component defined as the user's sense of being there in the VE (Pallot et al., 2013). Engagement is a component defined as the energy in action, the connection between a person and its activity consisting of a behavioral, emotional, and cognitive form. Immersion is a component defined as the "illusion;" that is, the virtual environment technology replaces the user's sensory stimuli by the virtual sensory stimuli (Witmer et al., 1998). Flow is a component defined as a pleasant psychological state of sense of control, fun, and joy the user feels when interacting with the VE (Heutte et al., 2010). Skill is a component defined as the knowledge the user gain in mastering his activity in the virtual environment (Murphy et al., 1989). Emotion is a component defined as the feelings of joy, pleasure, satisfaction, frustration, disappointment, anxiety of the user in the VE (Pekrun et al., 2011). Usability is a component defined as the ease of learning and the ease of using the VE (Brooke, 1996). Technology Adoption is a component defined as the actions and decisions taken by the user for future use or intention to use the VE (Venkatesh et al., 2003). Judgment is a component defined as the overall perceptions (clarity, originality, practicality, etc.) of the experience in the VE (Hassenzahl et al., 2003). Experience Consequence is a component defined as the symptoms or "simulator sickness", stress, dizziness, or headache the user can experience in the VE (Kennedy et al., 1993).

This model applies to this study by focusing on the overall experience of the user. The UX model combines the above constructs to describe the experience of users in virtual environments. Studies have focused on how improved scores in the presence, immersion, engagement, skill, and flow can boost effectiveness in VR experiences. Mikropoulos et al. (2020) created an AR system allowing parents, special educators, and therapists of children with autism and sensory overload to experience the same effects, which was found to be convincing, comfortable, and user-friendly through user experience. Usability, technology adoption, and symptoms are also the main component that should be considered when designing VR experiences, and these constructs were used to determine how our experience affects users. User experience helped Alenazi and Demir (2019) determine design and engagement problems with a virtual tour.

Purpose and Research Objectives

The purpose of this qualitative study was to determine the feasibility of a VR curriculum to provide a useable and realistic experience for agricultural education teachers. The central question guiding this study was: "Does virtual reality provide a realistic experience and supplemental option for skill-based education?" The study was further guided by two research objectives:

1. What was the lived experiences Ohio agricultural education teachers' who implemented a virtual reality experience into their curriculum?
2. What was Ohio agricultural education teachers' sense of realism in the virtual reality program?

Methods

The qualitative questions were addressed by using a transcendental phenomenology design, which is meant to reduce the individual experiences with a phenomenon to a description of the universal essence (Creswell, 2007; Creswell & Poth, 2018; Yin, 2016). The phenomenon in this study is the essence of the VR experience in which the teachers are participating. According to Moustakas (1994), the procedures consist of selecting a phenomenon, fleshing out one's experiences, and collecting data from several people who have experienced the phenomenon.

VR Experience

The virtual reality program utilized for this study was a curriculum resource developed with USDA-NIFA funding under the Youth Farm Safety and Education Program, titled Safety in Agriculture for Youth (SAY). This tractor safety simulation was designed at The Ohio State University using software services of Victory Enterprise, Inc. The software program operates on the Oculus Quest/Quest 2 VR headsets, which

comes with a right and left controller and uses a USB-C cable to connect to the computer. The VR program was based on the operating skills and driving courses within the National Safe Tractor and Machinery Operation Program (NSTMOP). Throughout the development process, the experiences received reviews from a content advisor and three Extension representatives who have taught and certified students through the NSTMOP program. It was pilot tested with 15 college of agriculture and related sciences students enrolled at The Ohio State University. It is important to note this VR program is not meant to replace the in-person tractor driving component but to act as a supplemental resource for the live offering of the course. In the virtual environment, participants can move freely between three different areas. Upon entry, the area to their left has a barn and stationary model tractor. Users can interact with the tractor to review safety content related to their classroom curriculum. The skill testing area is outside of the barn. This area was designed to represent the skills test portion of the Department of Labor (DOL) certification program. Here, the users interact with a stationary tractor's power take-off (PTO), hydraulic connections, and implement hitch. The final area is a virtual driving course. This course was modeled after the NSTMOP driving course and satisfies the DOL certification criteria. Users are required to answer questions intended to represent pre-operational checks they would conduct on a real tractor before they drive it. Once the checks have been completed, users must safely mount the tractor, fasten the seatbelt, start the tractor, engage the correct gear, and successfully drive the course. Points are accumulated if users brush, strike, or knock over an object or mount the tractor incorrectly.

For this study, an Oculus headset with instructions on how to use the headset, and steps for completing the program were sent to agriculture teachers who consented to be a part of this study. As a licensed teacher, agriculture teachers are identified in the DOL legislation as qualified instructors to teach agricultural related topics including tractor and machinery safety. The NSTMOP curriculum is one of several curricula teachers can use to teach tractor and machinery safety. As headsets were delivered by the researcher, teachers were instructed on the use of the of the technology and provided a video link with the same information. Teachers were provided two weeks to review the instructional card and video which provided detailed instructions to operate the VR technology as well as complete the experience. Within this time, they were asked to review the instructions and complete the experience themselves. Then, they were instructed to introduce the experience through their curriculum to their students.

Population and Sample

The population of this study were Ohio SBAE teachers. A volunteer sample of SBAE teachers were recruited from the frame to incorporate a VR safe tractor operation experience into their curriculum; these teachers were then purposively sampled for this study. Teachers who were sent a headset were provided with a notecard to sign up for a semi-structured interview upon completion of the experience. Interviews were scheduled once teachers consented to the interview. A total of ($n = 11$) teachers volunteered to participate in the interviews. Polkinghorne (1989) recommends researchers interview 5 to 25 individuals who have experienced the phenomenon.

Data Collection

Participants engaged in a one-on-one, semi-structured interview. Interviews were conducted via Zoom and transcribed using the Zoom transcription services. Transcripts were compared and corrected against the recording to ensure the interviews were transcribed verbatim. Participants were asked to describe and explain their prior perceptions of VR technology. This led into the discussion of how the experience was used by the participant. Participants were asked to rate the realism of the experience and to describe that score. To end the conversation, they were asked about their after-study perceptions of VR, as well as any positives or negatives related to this experience. The interviews ranged from 25 minutes to 45 minutes in length. Interviews were conducted until results reached saturation with eleven teachers participating in the semi-structured interview.

Data Analysis

Moustakas (1994) recommended a phenomenology follow the structured method of describing the personal statements, developing a list of significant statements, grouping the statements, creating a description of “what” participants experienced, drafting a description of “how” the experience happened, and write a composite description of the phenomenon. The qualitative data were analyzed for significant statements, sentences, or quotes that provide an understanding of the experience. Those items were highlighted and developed into initial codes, then into meaning units, and finally into themes. Those themes were then used to create the textural and structural description of the users' experience, data were then triangulated between the other participants responses (Creswell & Poth, 2018; Moustakas, 1994). Reliability was ensured by obtaining detailed descriptive transcripts. The interview data were coded by one person. An external audit was conducted with a faculty member to examine the process and the product to assess accuracy (Creswell, 2007). To ensure trustworthiness, member checking was conducted with 4 of 11 participants (Creswell & Poth, 2018). As data were analyzed, a new question emerged replacing a previous one guiding this objective. Instead of describing the teachers’ user experience, emerging themes described teachers’ experience of integrating virtual reality into their classrooms.

Reflexivity Statement

It important to note the limitations of this study, due to non-probabilistic sampling methods the results can only be generalized to the participating data sample. Additionally, the biases of the researchers which helped develop the VR experience.

Findings

Through the first research objective we sought to describe agricultural education teachers’ lived experience of implementing the VR experience into their curriculum through semi-structured interviews. From these interviews, three major themes emerged, with 11 sub-themes as shown in Table 1.

Table 1

Themes and Sub-Themes of SBAE Teachers

| Themes | Sub-Themes |
|--|--|
| The experience provided valuable benefits. | <ol style="list-style-type: none"> 1. Using unique content engagement to provide unattainable experiences. 2. Promoting enhanced engagement through technology and social collaboration. 3. A positive educational experience having future implications. 4. Mostly no symptoms were experienced except minor motion sickness and dizziness. 5. The experience made a typically dry topic more interesting. |
| New technology brought new challenges. | <ol style="list-style-type: none"> 1. Teachers have little experience with virtual reality requiring necessary practice and experimentation. 2. Virtual reality requires teachers to be thoughtful about classroom and resource management. 3. Access to technology affected experience and learning. 4. The experience brought out the users’ negative contextual emotions. |

| | |
|---|---|
| The experience provided a semi-realistic interpretation of a hands-on activity. | <ol style="list-style-type: none"> 1. The program did not allow for instinctive action due to the limitation of VR. 2. The presence and sense of space was realistic. |
|---|---|

For Objective 1, two major themes emerged from the data were teachers' thought the experience provided valuable benefits, and they experienced new challenges brought on by new technology.

Theme 1: The experience provided valuable benefits

Theme one emerged from the benefits that the teachers described from the experience. All the teachers shared that this experience helped them provide an experience the teacher could not provide, an experience that a student was unlikely to have, or even helped them alleviate nervousness or fear around machinery. Teacher 2 said "the fear factor wasn't there, so they could actually try driving without getting on the equipment. We saw that with some of the kids, so I was impressed with what I saw teaching it."

Most of the teachers said they saw an increased level of engagement from students who do not usually engage with the class and that this promoted a higher level of social collaboration. Teacher 6 stated, "It was kind of neat to watch the kids who typically are not like the straight-A, really engaged kids, they were the ones who were teaching." This engagement depended on the previous experience students had with VR and machinery operation and could often be used to identify students not have any driving experience. Teacher 2 saw that one of her students had prior VR experience and that experience held her back a little bit: "She was also one of them that does VR a lot, so she was trying to walk, like physically walk, around the tractor. I was like, no, no, you have to stand still."

Most of the teachers mentioned this was a positive, fun, and educational experience still having plenty of potential for safety training, as well as other areas in agriculture. They also mentioned there were minimal symptoms, common with VR, that were experienced by them and their students. This led to positive emotions from both the students and teachers. Teacher 3 said:

I don't think this is something that just one-to-one replaces [the way you teach]. I think it takes it to the next step, which is what you always want in education. You want to figure out what you're currently doing and how the students can improve their knowledge and skills. I think that VR could be something that you could do with those students.

As mentioned above, teachers understood how a technology like VR could enhance their program by providing experiences students, otherwise, would not be able to experience. The proceeding sections break this theme into more descriptive sub-themes.

Sub-Theme 1: Using unique content engagement to provide unattainable experiences

Almost all teachers shared this experience allowed them to provide students with an experience they would not normally get or allow them to practice an activity for which they do not have equipment. Teacher 4 said she usually just teaches the safety curriculum because her students come from a more urban area. She understands they don't have that experience: "Because again a lot of my kids are not going to have that opportunity to get on a tractor or to have, they may be on a small lawn tractor." Teacher 5 was in a similar situation where she also did not have the equipment available to teach her students and understood this was a "kind of like a low stakes way to teach people, and I could see this being used in the training field outside of a classroom setting." Teacher 11 stated, "For an urban agriculture class like mine that kind of virtual experience I think it's really, really cool because I cannot provide that to my students because I don't have that equipment, it's not in my community." While most teachers echoed these sentiments, Teacher 8 has a program that manages a large school farm. While he felt like the experience was good for giving experience it wasn't a good fit for him: "I teach a program where we manage a [large] school farm, so we

have real tractors that we drive operate, real combines, so in fairness, to that, it's never going to compare to the real thing.”

Sub-Theme 2: Promoting enhanced engagement through technology and social collaboration

Teachers saw enhanced engagement in their students while they participated in this experience. Teachers noted students who were previously more reserved became more engaged because this was a technology they knew and understood. It also allowed them to help both other students and teachers who didn't have experience with this technology. Teacher 4 said, “That was unintentional - was the teamwork of it, so as one kid was struggling, and they were watching on a TV another one coming beside them and started to coach them.” Related, Teacher 6 said, “it was kind of neat to watch the kids who typically are not like the straight-A really engaged kids, were the ones who were teaching the other students.” Students were overall highly engaged through the activities in the experience. According to Teacher 1, “I think the opportunity to use brand new technology and do it in this setting was really, really engaging for kids and they were fully immersed in the experience.”

Over half of the teachers stated, depending on the students' previous real-world experience, their experience in the program was different than what was expected. Most teachers found their students with no farm experience did better in the experience than students having farm experience. Teacher 8 noticed his students “were more frustrated, like it was because the program itself just wasn't responding like they felt it should. It wasn't that they couldn't do it, but they wanted to be able to do the physical motions.” Other teachers dealt with frustration and tried to coax students through the experience when they wanted to quit. Teacher 8 stated, “They would get really frustrated and they would just want to stop, and they won't even want to finish the course and I had to really do some coaxing.” Teacher 2 said:

I would say it definitely helps the kids that haven't driven tractors their whole lives and aren't used to it, I have some kids that work on some pretty big machinery for their farms and the dairy farms like they're out pulling choppers, manure spreaders, and everything like that on a daily basis and they're driving skids loaders like the best of us. So, I mean, some of the kids that definitely haven't driven before, they picked up on it, and a lot faster. They kind of did, I don't want to say better than the kids that have driven a tractor before, but they picked it up better in this setting.

Due to the students that had more real-world practice struggling with the VR experience, it allowed students who had VR experience or who picked up the driving easy the opportunity to help others. Having technology that students could identify with allowed for them to become more involved with content and other students.

Sub-Theme 3: A positive educational experience having future implications

An emergent sub-theme from the teachers was this experience was positive, provided sensible educational content, and has plenty of potential for future use. Teacher 4 described VR as so important that “... the adoption of this is a non-negotiable in my mind. I just wish there were more experiences, that would open the door to more options for our kids.” Teacher 8 saw that while it was applicable for him at this moment, he could see the potential an experience like this could provide for students: “I understand this at the beginning, so I think there's a lot of potential there.” Teacher 6 thought that getting to use the VR technology in the classroom was the exciting component bringing students into it:

I think, overall, it was a positive experience, and I think anytime that you add a novel experience like this, kids don't always get to use virtual reality, and especially in the classroom, I think that brings a level of excitement for anyone because it is something different.

Teachers were able to see the potential VR has in the educational setting. Teacher 6 went as far as to say she wished “there was more valid experience like this one available” and she “would love to incorporate more experiences like this one” into her classroom.

Sub-Theme 4: Mostly no symptoms were experienced except minor motion sickness and dizziness

Almost all the teachers reported this experience did not produce any significant negative symptoms common VR experiences might cause. Only a couple of teachers said they experienced motion sickness, but not experience this to the point they needed to quit using the headset: "I don't know if it was just the closeness and all that stuff that, I just wasn't used to the motion sickness yet." Teacher 11 said he did not like the feeling of coming out of the headset and getting reoriented to the real world: "When I came back out of the virtual reality environment, especially in the longest session I did find that my eyes took a little bit of time to readjust to real-world lighting and real-world spatial dynamics." Other teachers reported no side effects of using the VR experience, Teacher 2 said she did not experience anything personally, but did notice the students:

...went out and had fun and played with the barrels ... I think it was the kids' extra time spent in the headset, but I would say the kids did just the test, and then the driving test itself were fine.

For the most part, teachers described few instances where they experienced motion sickness while in the headset and little to no other symptoms.

Sub-Theme 5: The experience made a typically dry topic more interesting.

This sub-theme breaks down the positive contextual emotions experienced by the teachers and students, which focused on collaboration, excitement, and competitiveness. Multiple teachers described students becoming competitive with each other, trying to get the lower (better) score, which translated into them having fun with type of topic. Teacher 1 said:

I really liked it, it was honestly fun, it made learning fun is what it did, and I know this is all about tractor safety, which is definitely not one of the most engaging topics, but I think it was good that it was done over a nonengaging topic.

Teacher 2's students "had a lot of fun. I think a lot of the kids really enjoyed trying to at least, and even if it wasn't necessary to do the test, like the safety tests, they just wanted to drive the tractor." Teachers described the students as "excited" they got to try something new like VR in class and expressed gratification it made an "not so interesting topic interesting again."

Theme 2: New technology brought new challenges.

Although the first theme unpacked many positives of the VR technology, the second broad theme emerged from the challenges that arose from trying to use new technology like a VR headset in the classroom. This theme broke down into four sub-themes. All the teachers mentioned they had little to no VR experience and needed to practice with the headset on their own. Teacher 8 felt that "Just for having it a couple of months I wasn't extremely familiar with it, so it took me a lot of time to figure it out."

Some of the teachers dealt with the challenge of trying to manage the classroom with only one headset and making sure all the students stayed on task. Teacher 3 felt the teacher "needs to be invested in VR" before trying to integrate it into their classroom. Teacher 5 felt because he used it as a "side activity," students were not able to see the benefit of using it as an educational tool. All the teachers described technological issues of some kind. Teachers had issues with navigating and using the technology, connecting to their school computers, and trying to cast the experience to their projectors. Teacher 9 said:

The biggest struggle that we had was trying to get the students trained through it. Then our technology doesn't always work with all the other technology out there, our school pretty much locks down our computers, I can't download programs, I can't do anything. So, the casting part did not work for us. The proceeding sections break this theme into more descriptive sub-themes.

With VR still being a relatively new technology in this setting, teachers were open to trying it out. Learning curves and access to technology emerged as the main issues teachers faced while using the equipment.

Sub-Theme 1: Teachers have little experience with virtual reality requiring necessary practice and experimentation.

All teachers who used the VR technology for the first time encountered learning curves and technology barriers that inhibited them from learning how to use the technology. Teacher 4 stated, "I had to go back and watch the YouTube video that you provided so that I was sure that I walked through the process correctly, and again I think that's a generational thing probably." Some teachers went as far as to have their students help them work through the technology. Teacher 2 stated that:

Coming in, not knowing anything was really cool, but my students were able to kind of talk me through it. I have a couple (of students), ... that's what they do for games, that's all they have is VR, so they could kind of talk me through it.

While some teachers had technology or gaming experience, they did not have experience with VR technology. Teacher 2 also stated she was always interested in VR but never really "had the opportunity to use it" or determine if she wanted to get it. Teacher 11 described himself as "top of the game" when it came to technology: "People would come to me and be like ... how do I do this thing and I'd solve it" but VR always seemed to be "way beyond" what he usually does and was a "bit of a jump" to learn how to operate it.

Sub-Theme 2: Virtual reality requires teachers to be thoughtful about classroom and resource management.

Teachers identified time as one of the biggest factors toward making the most of implementing the experience in their classrooms. It was often stated it took too much time for the students to get through the experience. Teacher 1 said, "the biggest challenges I had was getting the kids involved with it and doing so in like a timely manner because I didn't do this with every class." Related, Teacher 3 said, "It takes up a lot of time, so you'd have to get three or four going at the same time." Teacher 3 wished he had more headsets to allow students to use them simultaneously and other students would have something to do while others are busy. Related, Teacher 5 said his biggest challenge was teaching his whole class with just one piece of equipment.

Sub-Theme 3: Access to technology affected experience and learning.

The third sub-theme focused on teachers who brought up different barriers that prohibited them from using this technology correctly such as this experience feeling more like a game than a learning tool and not having the ability to cast what was on the headset to their computers. Teacher 5 felt his students "saw it more as a fun activity versus a learning activity" and Teacher 8 compared this to a welding simulator they had used in the past:

We used a welding simulator and I felt like it was pretty accurate - your position had to be held right and your materials were right here. You actually had to set some things up like you would really be welding, whereas this you just kind of put this on like you do a video game.

Other teachers focused on technological issues such as casting or Wi-Fi issues. Teacher 11 said, "we had a variety of issues with casting from either getting the headset connected to the school's Wi-Fi or the Wi-Fi not being strong enough to be able to support the casting or just having the content blocks." Teacher 5 stated, "I couldn't really teach those students because it was hard to teach it without looking at it, so I was trying to remember the steps to guide the students."

Sub-Theme 4: The experience brought out the users' negative contextual emotions.

This fourth sub-theme breaks down the negative emotions experienced by the teachers. The negative emotions focused on apprehension, being overwhelmed, and feeling frustrated. The biggest negative emotion experienced was related to frustration. Teacher 3 experienced frustration around not being able complete certain actions in the experience, which led to restarting the experience: "Doing that with students can be very frustrating, though, when the things want to kick you off, and you have to completely

shut down.” Teacher 5 and his students got frustrated when they could not figure out what to do next or which buttons to click: “I think lots of them are getting frustrated and they're like I don't I don't know where I'm going or I don't know what I'm clicking, and which button do I click.” Teacher 2 stated she felt some nervousness around teaching with new technology and lack of student previous experiences related to equipment operation:

There was definitely - like I had a little bit of nervousness about teaching [with] it just because to do something completely out of my, like real, out of my comfort zone not only the VR but teaching some of the kids who have never driven a tractor before.

This frustration and nervousness experienced by the teachers and the students prevented them from using the technology in a beneficial way. Teacher 5 and 6 who both had negative experiences were skeptical about using VR equipment again after this experience.

Theme 3: The experience provided a semi-realistic interpretation of a hands-on activity.

The second research objective sought to describe agricultural education teachers' sense of realism in the virtual reality program through semi-structured interviews. Teachers were asked on a scale of 1-10 how realistic was the experience and then asked to go into detail about why they thought it was that realistic. From these interviews, one theme emerged from their responses, which described how realistic the teachers thought the VR experience was. Although the teachers described this as semi-realistic, there were some aspects that limited the realistic nature of the experience. All the teachers interviewed described some parts of the experience to be realistic. Teacher 1 described driving the tractor:

I would steer with the controllers, but I would also like move my hands in that direction, so I don't know if that was just like a me thing, but it felt really realistic, even though I consciously knew that I was watching a video or like playing a video game it felt really real.

Teacher 2 described it as realistic enough she went to reach for the steering wheel: “I also have caught myself like actually taking my hand and trying to move the wheel, instead of the joystick”. Even though the experience made the teachers feel they could reach for virtual objects, the limitation of VR prevented them from performing the instinctive movements they were used to doing.

Sub-Theme 1: The program did not allow for instinctive action due to the limitation of VR.

While the experience did provide some realistic features for the teachers to experience, some instinctive actions weren't as realistic as they could be. Teacher 1 described the prechecks students had to do more like checking a box: “The prechecks weren't as realistic because it's like if you were doing a precheck you'd actually have to go and like look at the thing, instead of here where you just checking a box.” Teacher 9 described it as currently imperfect: “It's not quite like how it is in real life, but it does give them a feel for it. It's not perfect, not yet at least.” For example, users had to click on the handle to mount the tractor. Teacher 6 felt “getting on the tractor and moving some of the controls weren't as realistic, but I'm not sure that they could be more realistic either.” Teacher 8 shared he or she expected to be able to do different things:

You could do things like a front-end loader and running a joystick on the loader because I struggle with a lot of kids understanding the plus sign. You know right tilts, left curls, and hooking up attachments. It just seemed like he got on and even though they were stressing the points about the seat belt, it's almost like he just kind of threw it in drive and took off. There was no clutching, braking, no power reverser. I think those little details, with the type of tractors and equipment, are important to make it applicable.

Comments like these demonstrate, in creating educational experiences like the one in this study, completeness of the experience is important. Realistic experiences can provide more relatable content for participants and in turn, can build knowledge from this experience. Teacher 8 also said that:

I felt like it would be more acceptable for somebody with a compact tractor, maybe a residential person. More so than what we would do in production agriculture, but it almost seemed a bit generic compared to what we would be using.

As the teacher mentioned above, the tractor in the experience differed from ones they were used to and didn't feel it helped his students due to the difference. Just because the tractors were different did not mean they were any less realistic.

Sub-Theme 2: The presence and sense of space was realistic.

The second sub-theme emerged from teachers speaking about how realistic, present and immersed they felt within the experience. There were certain components teachers felt were realistic, such as the driving course. Teacher 4 said the experience:

...was really good, like the concept of knowing how to touch the key and turn that on, how to unbuckle or buckle the seat belt, and how to step up onto the tractor. So, from an immersive experience I like that, things looked real.

Although Teacher 5 did not have a positive experience with the program, he still felt it had some realistic components, especially where all the parts were located. He said:

It was really detailed when you look, you're sitting on a tractor, the word seatbelt was where the location was, where the seatbelt is. You know to turn the key, it was down in the bottom right there, and that was very accurate.

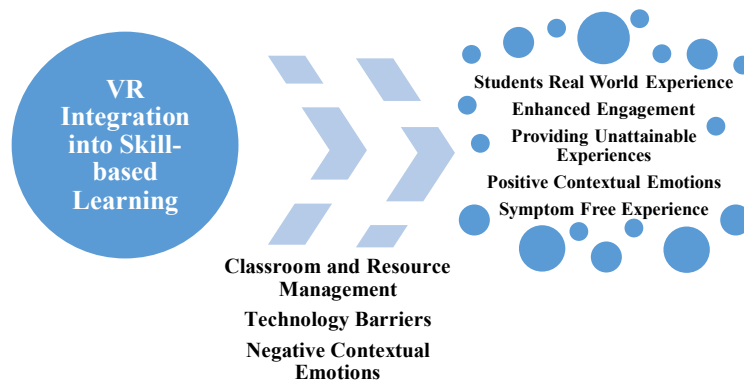
Even though there were critiques associated with the completeness of the experience, teachers were still impressed with the level of realism the experience was able to provide. They felt it helped students make connections between the real thing and the VR tractor.

Discussion

As a qualitative study, these findings are not generalizable, however recommendations can be made for readers to review and apply to similar situations as they see fit. To address the research objectives, agriculture teachers participated in semi-structured interviews to allow for their lived experiences to emerge. Three themes and 11 sub-themes emerged from those interviews, concluding overall teachers had a valuable and positive experience. To describe the essence of these results, it's important to look at these results as two separate groups: benefits of VR integration and barriers facing VR integration. Figure 2 displays how the barriers can potentially prevent students and teachers from seeing the benefits of integrating VR into skill-based learning.

Figure 2

Barriers of VR Integration Influence on Benefits



This figure graphically articulates the three main barriers impeding VR adoption as perceived by teachers. These were identified as classroom and resource management, technology barriers, and negative emotions. When these are present, it may be challenging for students and teachers to see the benefits of integrating VR into their skill-based activities. Even though these barriers are present, that does not mean some of the benefits of VR adoption cannot still be experienced. Teachers mentioned in their interviews, while they still felt frustrated at the casting technology, they were still able to provide students with a unique experience they would have not been given otherwise. Teachers were provided with one VR headset to use in their classrooms. Because of this, some wished they had additional headsets and teachers took longer to train their students because of having only one headset. Overall, from the emerging themes, it can be concluded this experience was positive and able to provide an engaging and unique experience; but more importantly themes described the valuable benefits VR can provide as well as the barriers impeding VR's integration.

Additionally, it was concluded teachers had a semi-realistic experience. Teachers went as far as to try to grab the steering wheel and other levers as if they were real. In addition, their bodies would move with the tractor as they drove and would respond to the movements and motions as if they were actually driving a tractor. However, teachers also reported not being able to do more instinctive actions like checking the oil or grabbing the steering wheel took away from the realism of the experience.

Wells and Miller (2020) found fairly agreeable opinions among Iowa teachers related to the integration of VR in SBAE programs, which align with some of the positive perception's teachers identified in the interviews for this study. They also found the teachers were unsure the benefits of VR would outweigh the potential costs. This supports the findings from the teachers' interviews regarding this experience providing valuable experiences for students. Their study also echoed some of the concern's teachers voiced regarding its use in the classroom as an educational tool. Although these barriers may seem trivial, it is in fact crucial for the successful implementation of VR in the classroom. This implies that until we attempt to alleviate the challenges and remove the barriers in place, teachers will only have semi-successful experiences with VR in their classrooms.

Lamb and Etopio (2019) found a VR versus real-life condition where preservice teachers had the opportunity to confirm, extend, or disconfirm their prior knowledge about how they will react in the classroom resulting in the construction of new knowledge, skills, and strategies was not significant. Their study did find it can promote learning from modeled real-life situations for the transfer of theory into practice. Lombard and Ditton (1997) argued when a user is not familiar with something, like virtual reality, unfamiliarity promotes a lower presence score and in turn can't be a realistic experience. Gisbergen et al. (2019) found even though differences in realism were observed they did not have an effect on experience or behavior. They found there might be other variables affecting the whole experience to essentially "obliterate" the effects of a better sense of presence and realism (Gisbergen et al., 2019). Gisbergen implies realism is important to the users' experience as well as making a successful integration of VR into a classroom or curriculum and can allow them to see the potential uses VR can provide. Also, other factors of the experience can negatively affect the users' experience and detract from the realistic nature. By ensuring educational experiences are as realistic as possible, it will make the experience more transferable to real-life situation so students can make those connections.

Because this study was limited in the number of classrooms, teachers, and students were able to use and complete the VR experience, the results are not representative of the Agricultural Education teacher and student populations. Further research needs to be conducted in a more structured setting to see the true effect VR can bring to the classroom. There is a small body of knowledge regarding the integration of VR into Agricultural Education, currently focused on VR welding experience, the recommendations presented here will add to this body of knowledge.

Further research should be conducted to assess teachers' opinions of using VR in the classroom and if they feel it is a novelty or a useful tool. From our findings, teachers described some of their students as having VR experience, so more research should also be done with them to see how they view VR technology. Further research needs to be conducted to develop an implementation program for teachers implementing a VR experience like this into their curriculum. The issues arising could be alleviated by providing teachers with a structured implementation guide.

More qualitative work should be conducted to explain teachers' perceptions of VR and how they view it as an educational tool. Work could also be done with administrations about their view of VR and what potential it could have for students as an educational tool. More work should be done with teachers to determine if the emerged themes are present amongst other teachers across the state or other states. Research should also be done to determine what other barriers may exist hindering the implementation of VR in educational settings. Work should also be done about teachers' perceived barriers to implementing VR technology into the classroom with a focus on teachers who have utilized the technology and teachers who have only seen it being used.

Realism is a concept not directly measured by the constructs of the user experience model, but the constructs of Presence and Immersion do relate to realism (Lamb & Etopio, 2019). Other qualitative work can be done to discover barriers causing an experience to be unrealistic. Quantitative work can also be done to discover potential relationships between the constructs of the user experience model and realism. More research should also be conducted to determine if there is a relationship between participants' user experiences and their perceived realism of the experience. Several constructs such as presence and immersion, have been shown to influence the realistic nature of a VR experience (Goncalves et al., 2022). So, more research should be conducted to determine if any of the constructs of user experience have a relationship or effect on the realism of an experience.

This study provides a starting point for individuals who are interested in integrating virtual reality experiences into a classroom setting. It is recommended state staff, administration, and teachers address potential issues before integrating the technology. Addressing these issues beforehand can relieve a lot of frustration in the future. State staff should try to provide continuing education opportunities for pre- and in-service teachers to interact with new technologies, such as VR.

Regarding this specific VR experience, more work should be done to optimize navigation throughout the experience. Users explained there were times they did not know what to click or where to go, by providing an anchored menu providing instruction could alleviate some of the frustration experienced. The level of immersion should also be expanded to allow user to complete more tactile actions, such as checking the oil, or grabbing the seatbelt. This will increase the level of engagement and allow users to complete those more instinctive actions they would do on a real machine.

Other opportunities at professional development conferences should be developed to allow teachers to see what is available and interact with the technologies if possible. State agencies should consider providing opportunities or incentives for districts to adopt VR technologies through funding opportunities such as grants or incentives. Teacher educators should provide an opportunity for pre-service teachers to experience using VR technology in an educational setting. Pre-service teachers should also be made aware of funding opportunities to supply their classrooms with VR technology. The opportunity to work with new technology can create collaboration opportunities with other departments across campus to provide pre-service teachers access to new instructional technology.

Some teachers described in their interviews their administration wanted to stay at the forefront of technology by having the newest equipment available, but most of the teachers disagreed they had the financial support to purchase this technology. Administrations should be made aware of the available

technology, and the value it provides for the teachers. As educational technology advances and evolves, and as research in this area continues, it will be important for educators and their administrators to be forward thinking in their pursuit of obtaining this technology. Administrators should make themselves available to see teachers try out new technology in their classrooms. Some teachers said their principals came by the class while they were using the headsets and even tried it out themselves.

This specific VR experience is a part of a supplemental piece of curricula tied to the National Safe Tractor and Machinery Operation Program and should be used with similar tractor and machinery certification programs. Teachers can use it with their curriculum but need to be aware of the content in the experience to ensure transferability between their curriculum and the experience. Therefore, teachers should make it a priority to integrate a potential VR experience into their curriculum and not use it as a side activity in the classroom. This will allow students to see it as the educational component it was designed as, and not as a game. Teachers should make sure they have properly reviewed the instructions and practiced the experience before introducing it to the students. Teachers should make sure they have used technology enough to feel comfortable using it in front of their students and to talk them through the basic steps.

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