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ALL-SCHOOL AGGREGATED FINDINGS 2016-2017 - VR

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Applied VR in the Schools, 2016-2017 Aggregated Report

Introduction to the Study

In 2015, we were approached by a local teacher who was interested in giving his advanced computer science students access to virtual reality technology. He was hoping to acquire five Oculus Rift headsets so that his students could learn to create in virtual environments. We agreed to help him get the equipment for his school if he would allow us to visit and briefly chat with students about their experiences. That visit served as the impetus for a multi-year study involving thousands of students across the United States and Canada investigating the applied uses of virtual reality in the classroom.

The first study, done in the 2015-2016 school year, focused on implementation and management of VR in middle and high school classrooms. This report, of data from the 2016-2017 school year, is a broader examination of students as consumers and/or creators of VR content, immersion in classroom settings, student understanding of virtual content, the potential value of VR for learning, possible concerns students may have had about the use of VR, and an exploration of understanding of people and places through the use of VR.

In addition to survey data gathered at the beginning and end of student VR use, all teachers were interviewed three times during the school year (pre/mid/post) and, when possible, we tried to visit each school site once to view the VR set-ups and meet in-person.

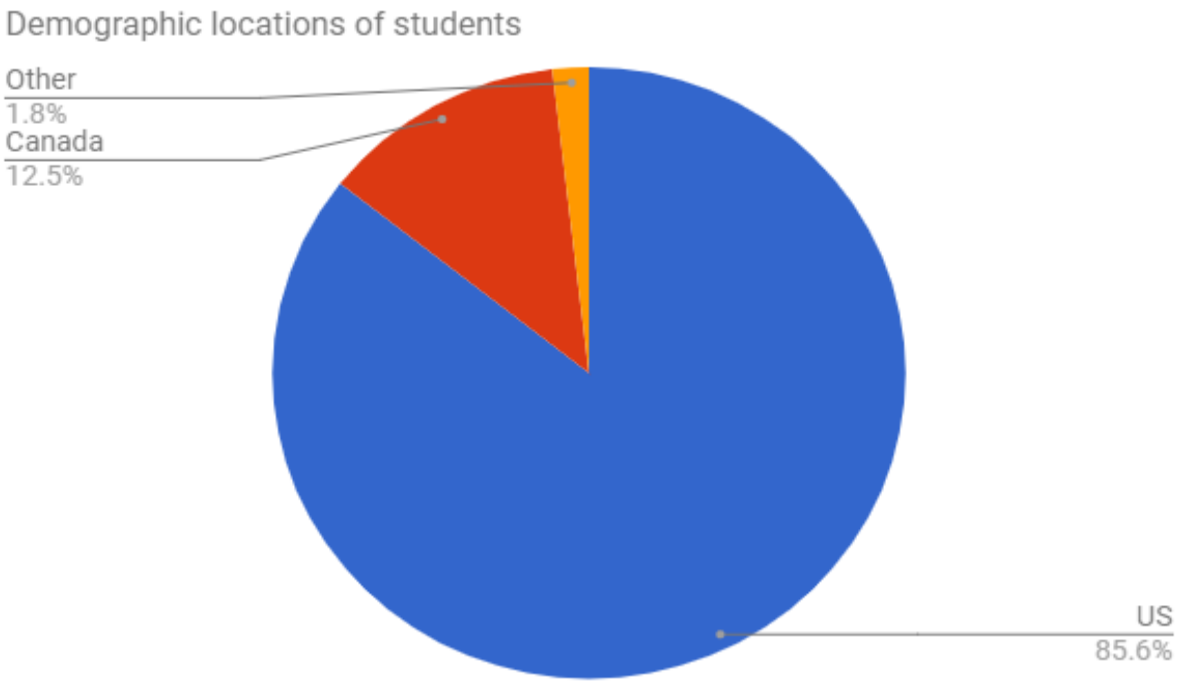
What follows is an overall summary of our findings from this study. Student surveys were grouped into two categories: VR Consumption and VR Creation. VR Consumers were students who came from classrooms where they viewed/engaged with VR content but did not create their own content. By contrast, VR Creation classrooms were also tasked with creating and/or modifying existing VR content as part of their learning. We made a point of including a wider variety of subject areas in this year's data-set, so there are tech-based courses as well as humanities classes represented here.

This was our first time administering the pre/post surveys in this format, as such, there were some errors in data collection, particularly in the post phase. The main issue was that not all classrooms were able to complete their post-surveys prior to the end of the school year. As such, we will present some data as matched pre/post data and other data disaggregated to represent only pre or post surveys. There were some errors in subject number entry by students so though we did gather useful post data, it was not always possible to match it back to their pre-data set. Where it is helpful, we have data grouped to match pre/post responses (to show a change over time). In other cases, we have findings from pre and findings from post, but not necessarily matched child by child. We have modified this collection procedure for the 2017-2018 Applied VR study in the hopes that we will not have the same kind of data-loss during the post-collection phase.

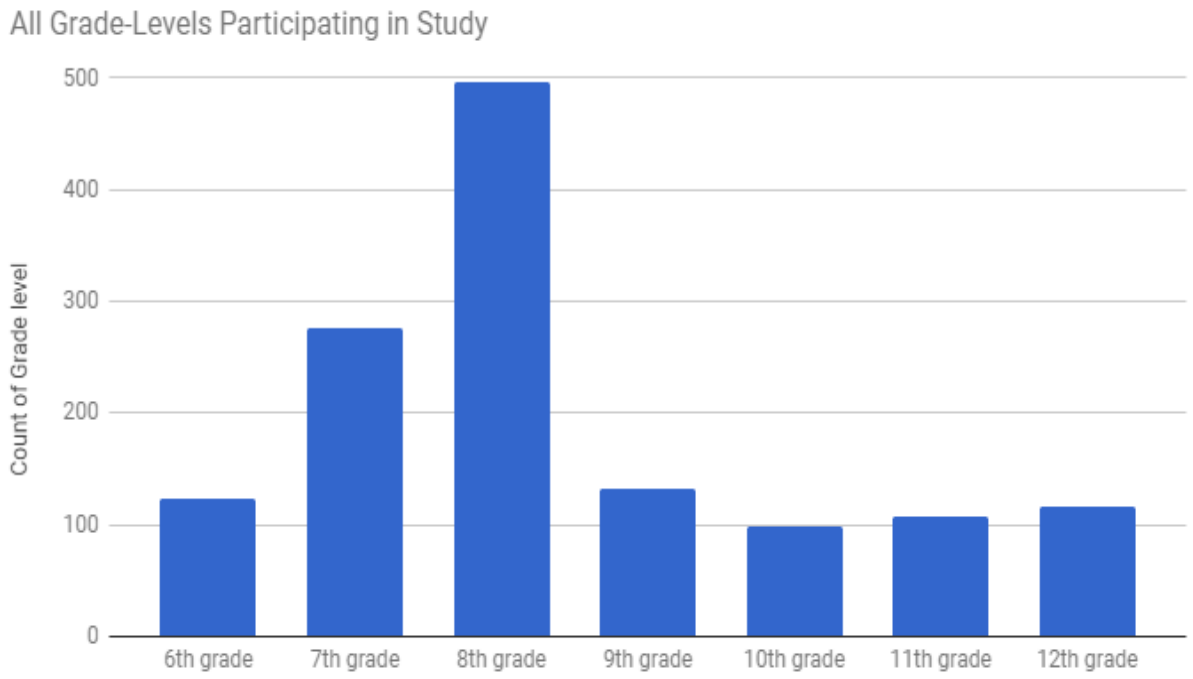
General Information about the Participating Schools

Schools and teachers were recruited primarily by word of mouth from participants in other foundry10 research. In the spring of 2016, we reached out to teachers who had expressed some interest in bringing VR into their classrooms. If a teacher expressed interest we contacted them via telephone to describe the study and what we would provide in exchange for gathering data. At that point, if the teacher was still interested we had them connect us to appropriate school officials so that we could follow school and district procedures for doing research. This report includes findings from our middle and high school participating schools (there is a separate document outlining findings from elementary school). We had 16 participating teachers in this study representing 13 different schools.

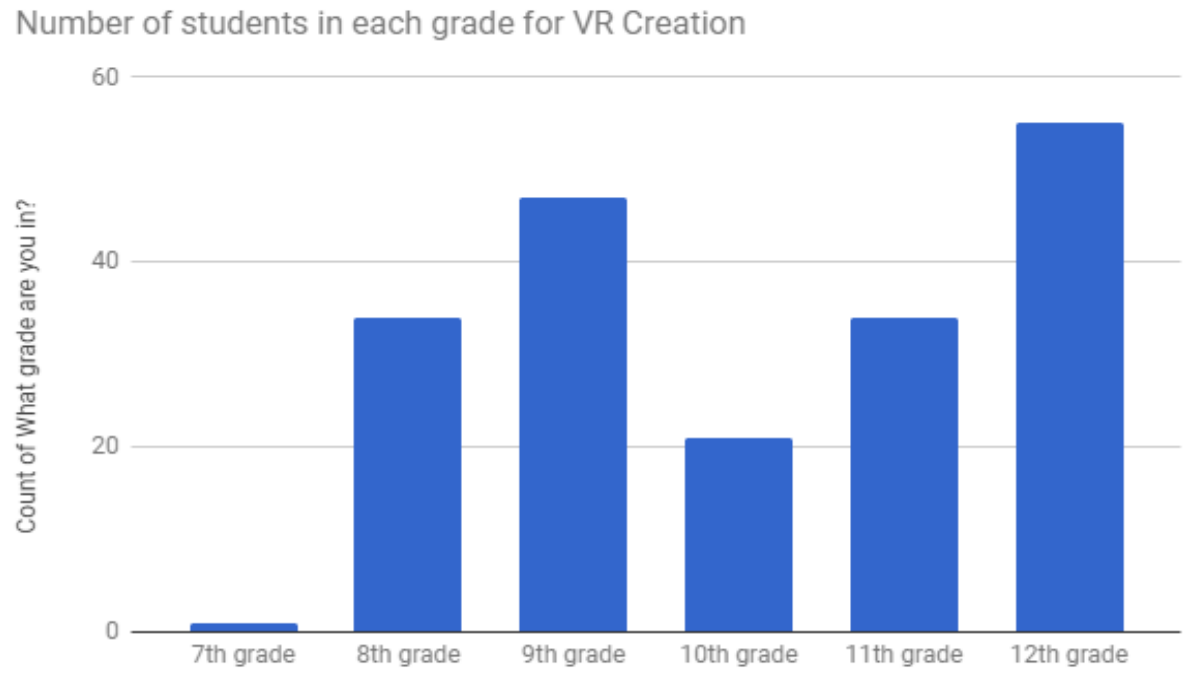
Student Demographics



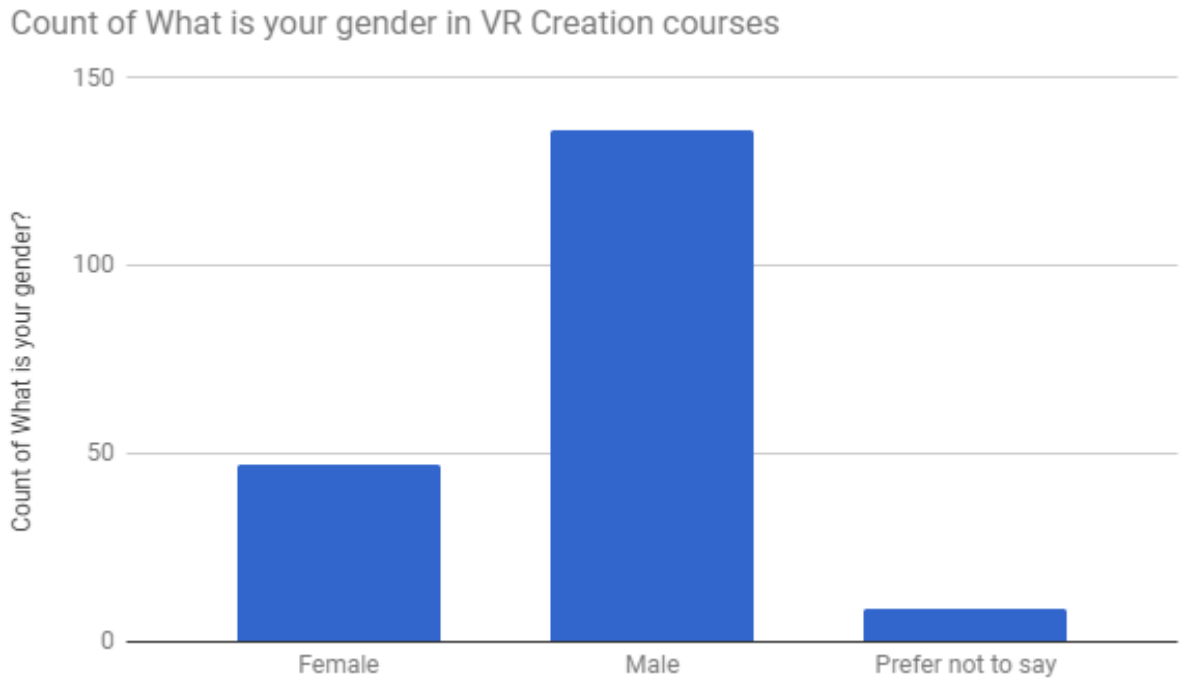
There were 1351 student participants across six grade levels. For study purposes, students were divided into three different survey groups: Students who Consumed VR Content, Students who Created VR Content, and Students who had One-Off VR Experiences. Ultimately, many of the questions overlapped across groups and we combined the data for efficiency. At times, we will disaggregate the data to highlight interesting differences between groups.



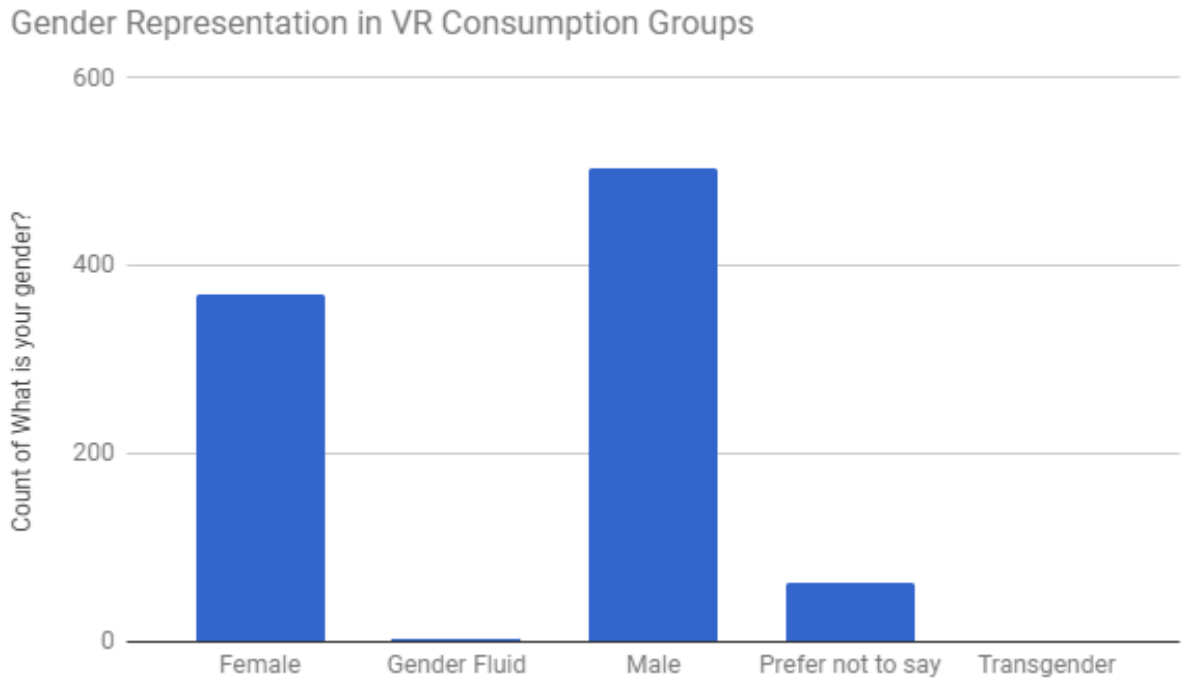
Demographics look slightly different for students in courses where VR content is created skewed slightly higher into the upper grades.



Aside from grade-level the other demographic data we were interested in was gender identity. As seen in the graphs below, there were more male students overall but the difference was more pronounced in the VR Creation courses.



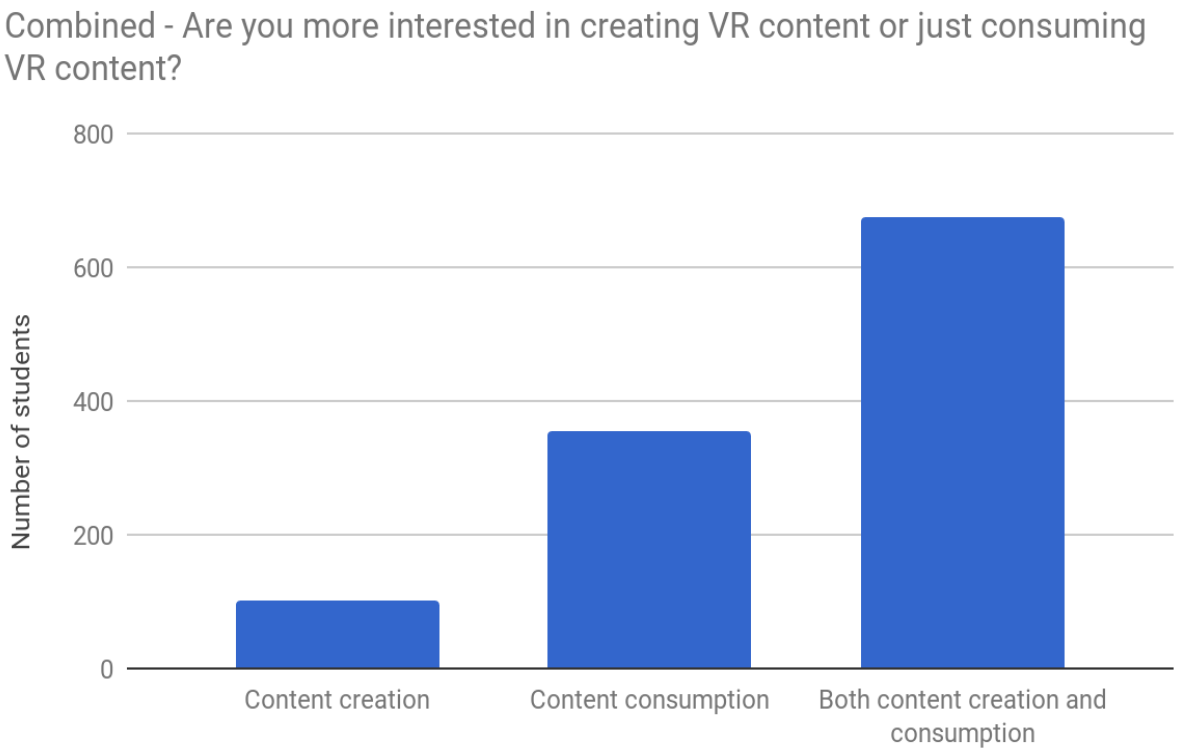
Gender identification in courses where content is consumed vs. courses where VR is created:



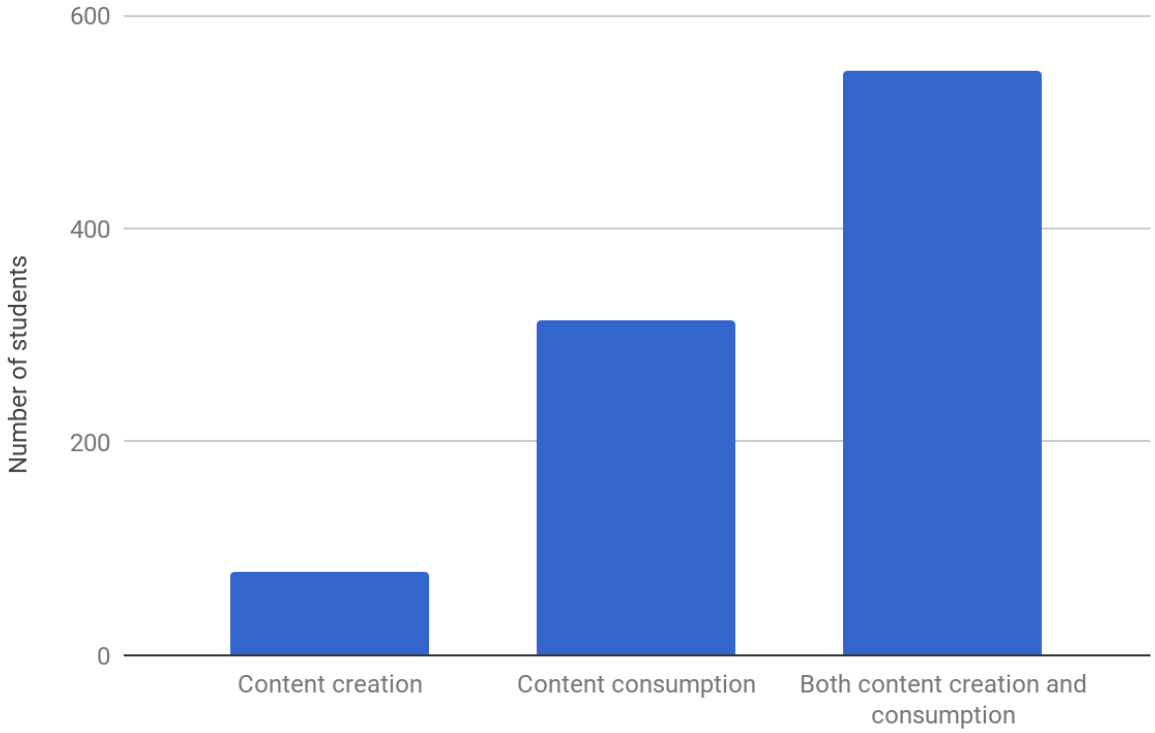
There is a higher percentage of students who identify as male in both VR Consumption and VR Creation courses. VR Creation courses were labeled as such based on the teacher's intentions for their course objectives. We asked teachers in their pre-interviews if students would primarily be creating or consuming content and then their students were given slightly different surveys depending on the course focus. In this study, VR Creation courses included classes in Programming, Advanced Computer Science, Game and App Development, and Fundamentals of Digital and Visual Arts. Worth noting is the fact that at least one middle school art program (classified as consumption) also spent a great deal of time creating artistic pieces in VR but did not do programming to create their own content. In effect, those students were also "creating" VR content in an artistic realm, but due to the fact that they were not coding experiences for others in software such as Unreal or Unity, they were not classified as VR Content Creators.

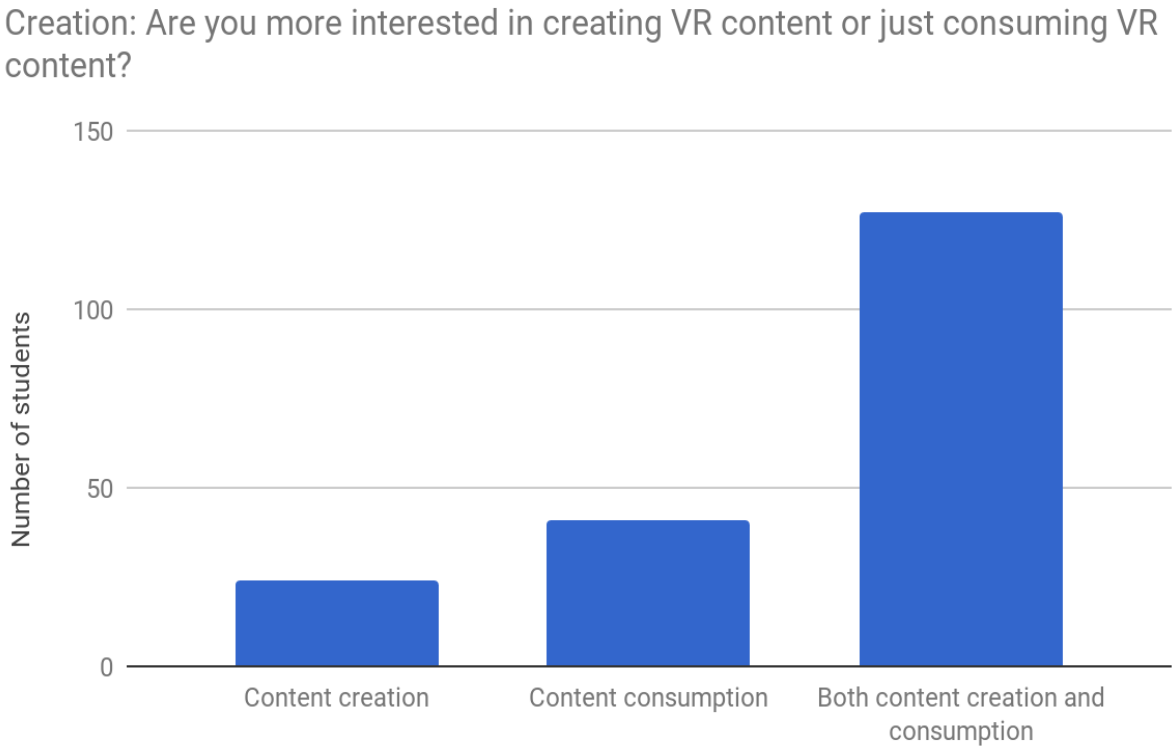
Content Consumption versus Content Creation

We found it intriguing to ask students about their intentions for using VR. Though most students were enrolled in VR Consumption focused courses the majority of students identified as wanting to both create and consume VR content.



Consumption: Are you more interested in creating VR content or just consuming VR content?

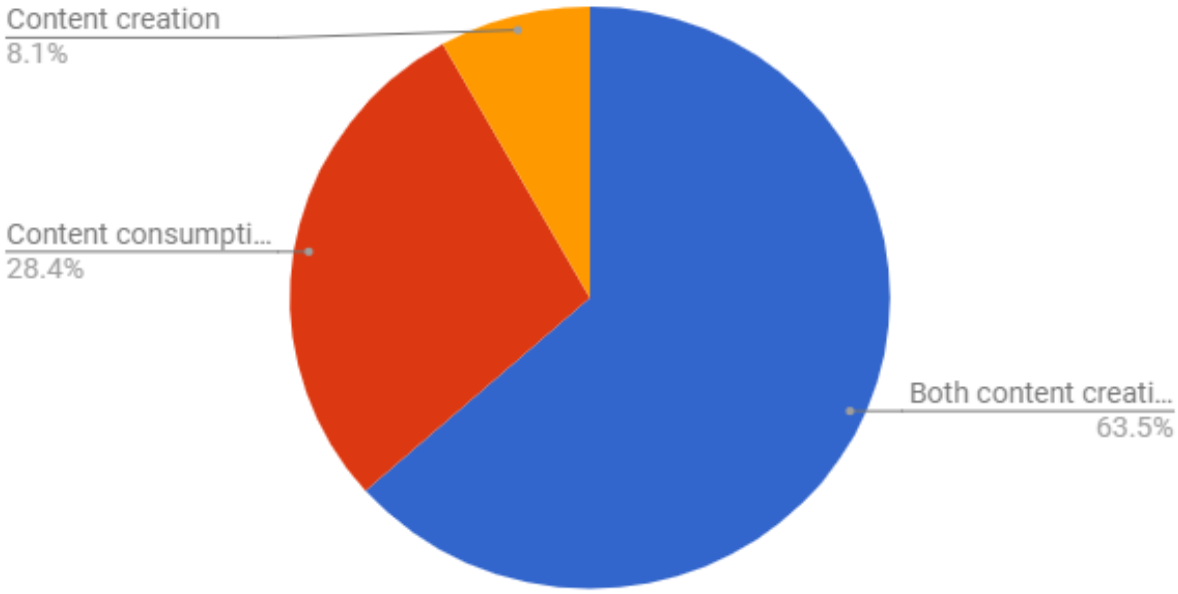




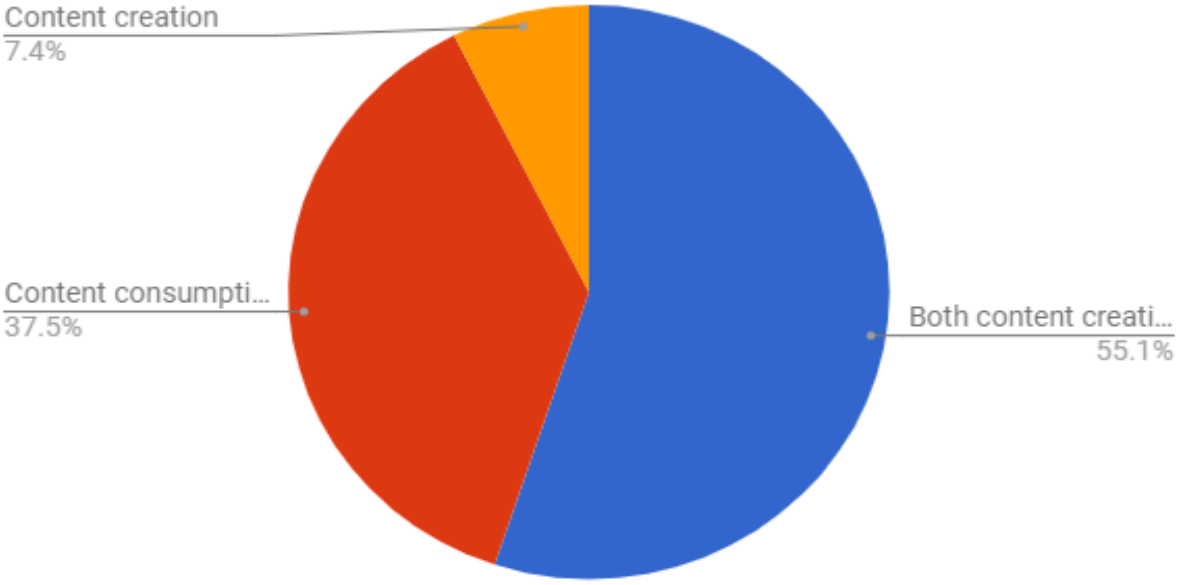
This is interesting to note when one considers the ways in which students interact with technology both in schools and at home. There is a plethora of tools in classroom settings as well as in their personal lives where students are empowered to be the "creators" of their own digital content, and it is intriguing to us that this appears to carry over into the realm of VR as well.

An interesting finding from the schools where we were able to gather matched pre/post data was that we saw a slight trend towards not wanting to be content creators at the end of the VR experience. In other words, a small subset of students (about 10% of the sample with matched pre/post data, approximately 400 students in content creation and consumption) who thought at the beginning of the study that they might be interested in both creating and consuming VR content found that, at the end of the study, they were more interested in only consuming content. The majority of those students were in courses where VR content creation was not the primary goal so it may be that as they gained a better understanding of what creating VR content entailed thus were less eager. Either way, the majority of students were still interested in being both content creators and content consumers after VR exposure.

Count of Are you more interested in creating VR content or just consuming VR content? Pre



Count of Are you more interested in creating VR content or just consuming VR content? Post



Subject Areas of Interest for VR

In our previous research we have seen some common themes in terms of subject areas that students believe VR would be well suited for and the themes have remained similar, although it has been interesting to note that as students seem to gain additional exposure to VR they seem to broaden their perspectives on what it might be used for. This group of students felt strongly that history and science would be great subject areas to explore in VR, a trend we have seen in previous studies. In conversations with students and teachers we understand that adolescents sometimes feel history is inaccessible and that if they could "travel back in time" to see or participate in these events, they feel their understanding of what occurred would increase.

We saw this anecdotally with high school students who had experienced a Pearl Harbor VR simulation. Most of the students had some understanding of Pearl Harbor, but by experiencing a simulation (non-battle) and looking at the site and artifacts, they expressed afterwards that their conceptualization of what happened was different. For instance, some didn't know that it took place at night, others didn't realize so much fuel was spilled into the water, and still others were unaware of how many soldiers lost their lives. Being in the experience, even within the context of having some prior knowledge from history class, helped them to further situate the experience and their understanding. In fact, we are curious about whether or not students with some exposure to a topic, such as the bombing of Pearl Harbor, might be able to extract more information out of the VR experience than students who have little to no knowledge of the experience. If this is the case, VR might serve as useful tool for helping with comprehension and understanding of content.

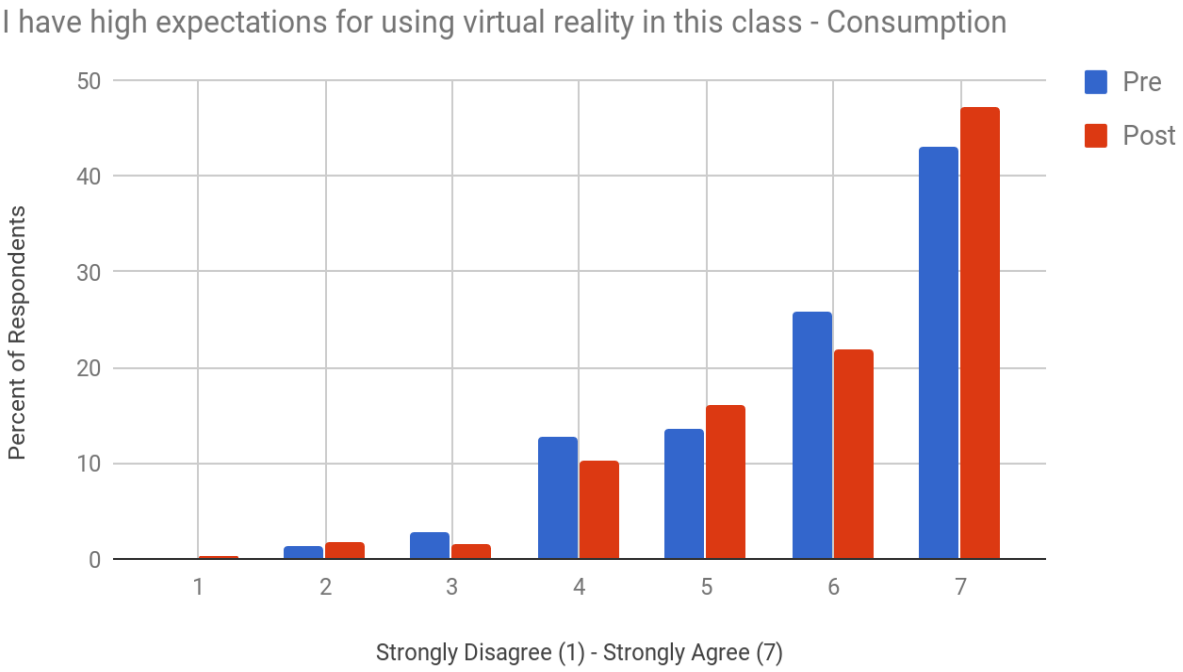
Science is also a popular subject for VR usage. Students often mention that they would be able to experience things or experiment with things (in an interactive capacity) that they might otherwise not be able to do in real life. Being able to experiment with things on a molecular level, playing around with "dangerous" chemicals, doing experiments with physics that are unique (e.g., not rolling a virtual ball down a ramp, kids know they can already do this, but watching the collision of larger particles, something they cannot do) is appealing on many levels to students.

This year we also had a large number of students reference art class. A couple of different classes that participated in the study were enrolled in art courses, and thus it makes sense that they were quick to mention VR as a tool for art class. Even some students not enrolled in art classes had experience with programs like *Tilt Brush,* which is an artistic VR experience, and found it to be a useful creative tool.

English was also mentioned many times by students as a course in which they could see VR being used. Common references from students implied that they could better understand the books they were reading if they were able to step into them and experience what it was like to be there (much like in history). In addition, we saw how teachers used historical VR experiences, or even *Google Earth* as tools to help students situate books they were reading into the appropriate environments or to gain an understanding of what it might be like to live in a large city, etc.

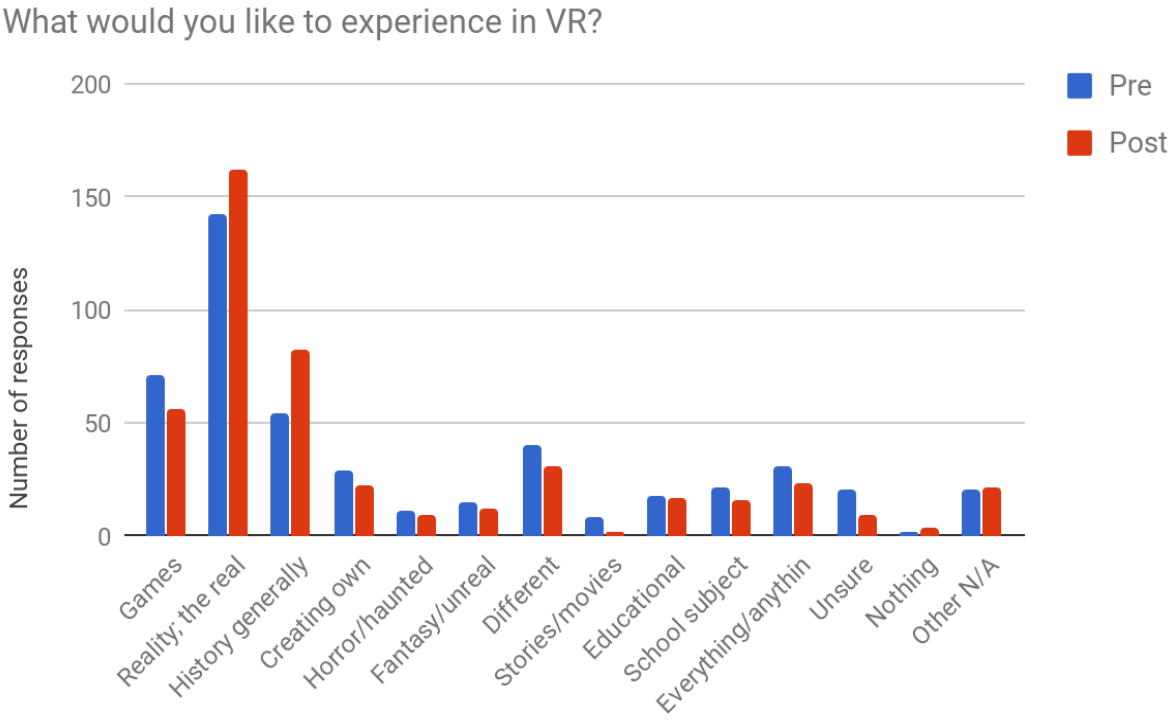
Student General Impressions of VR

Generally speaking, students had high expectations for using virtual reality both before and after using it. In the graph below, we analyzed responses from students who filled out both the pre and post survey. Their responses indicate that students had positive feelings about using VR in their classrooms.



Content Students are Most Excited to Experience

There is a wide range of content that students are eager to explore. Most students were interested in more than one area of virtual reality content, but the most popular answers were trying new things and really being “in” experiences.

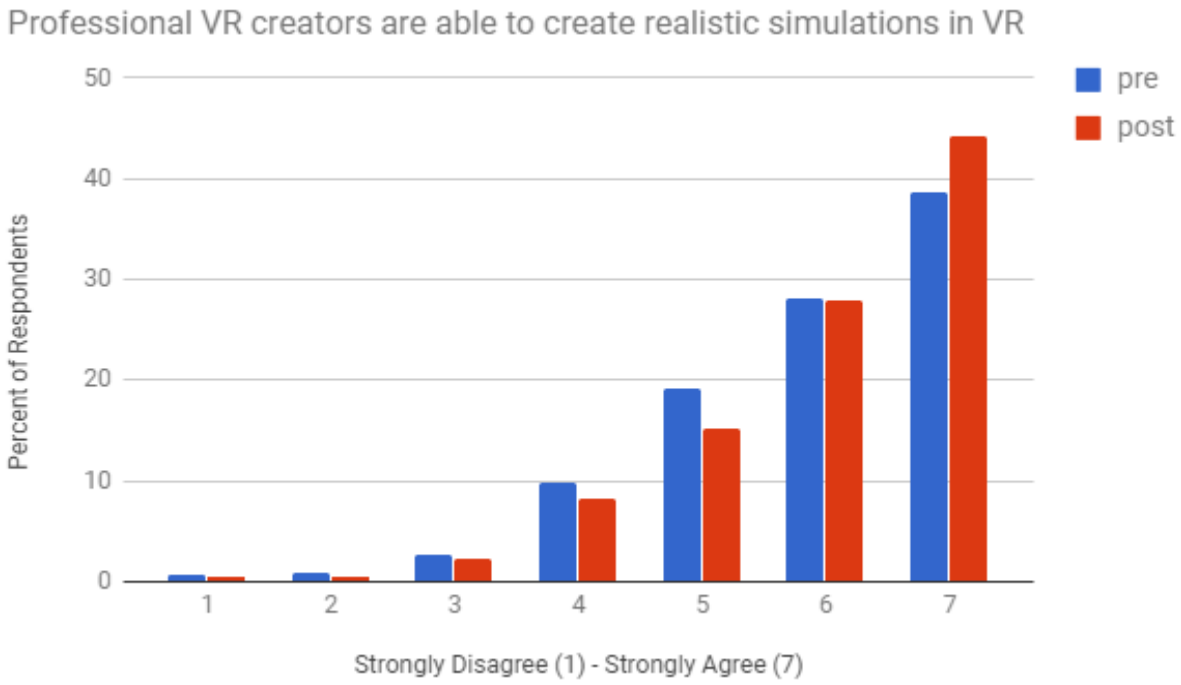


This graph is a representation of coded responses to an open response question. At the beginning of our study, many students who had never experienced virtual reality were not sure what would be most exciting to experience in virtual reality. A lot of the "other/NA" category was students saying "N/A" because they didn't know what was possible in virtual reality in the beginning. The highest category in both pre and post responses is trying new things. It's exciting that even after using VR technology in their classrooms, students still want to try new things in virtual reality. There are many interesting avenues through which students can interact with virtual reality, but it's indicative of student engagement with this technology that games is not one of the most exciting categories to them, as we expected it to be. Many mentioned games, but it was important to them that the VR experiences (whether games or simulations) introduced them to new perspectives, unreal things, and/or were life-like.

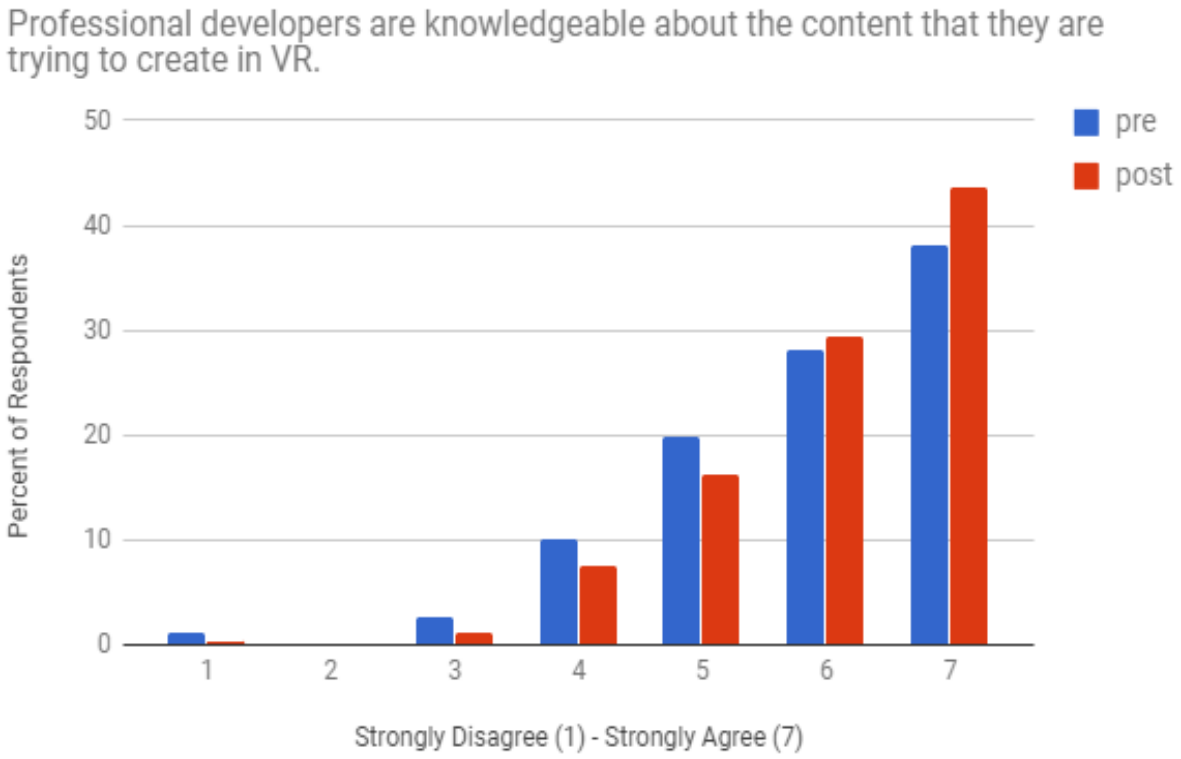
Impressions of Developers

One area we added this year was an investigation of how students thought critically about the media they were consuming in VR. We began that exploration by having them consider the people who are developing in VR and whether or not those individuals can create realistic simulations, how knowledgeable they are about what they are creating, and how much the students believe developers are thinking about the best applications of VR. The results were significantly more positive than we thought they would be.

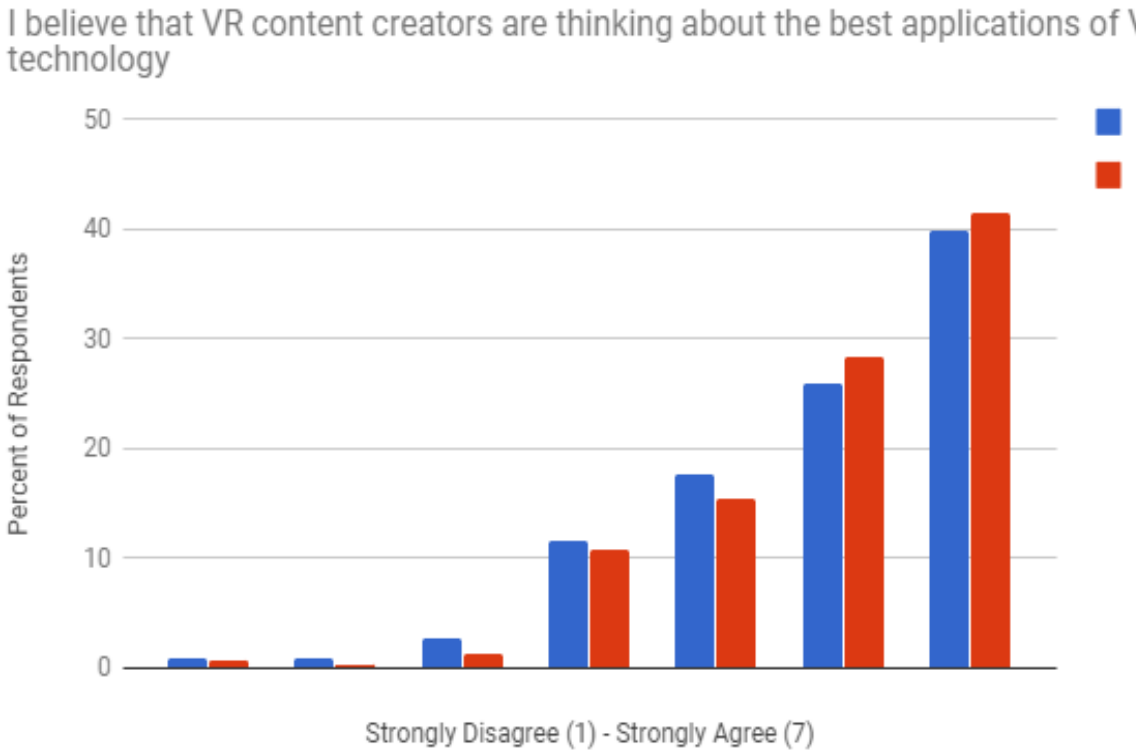
In both the pre and post conditions we see that students feel confident that professional developers are able to create realistic simulations in virtual reality. This is interesting given the range of experiences that students have had and their exposure to environments in which they might know some things (e.g., an underwater simulation) but are likely not experts.



The next category was "Professional developers are knowledgeable about the content they are trying to create in VR". This one, in particular, is fascinating given current discussions of media literacy and critical media consumption. Students (and teachers as per the teacher interviews; we also heard similar things from a parent focus group) have a great deal of faith that VR developers have content area knowledge. This has interesting implications for student/teacher critical thinking. Well-designed VR experiences would likely be a great asset for learning, but students and teachers need to be able to ascertain whether or not the simulations they are experiencing are based on good information. We know from our interactions that some developers go to great lengths to consult with experts to ensure the experiences represent accurate experiences to the degree they can (e.g., in the bloodstream) or to represent events with accuracy. Given both students' and adults' trust of developer knowledge, it will be critical for kids and adults in simulations to differentiate between what is factual and what impact the developer's perspective has on a particular set of content.

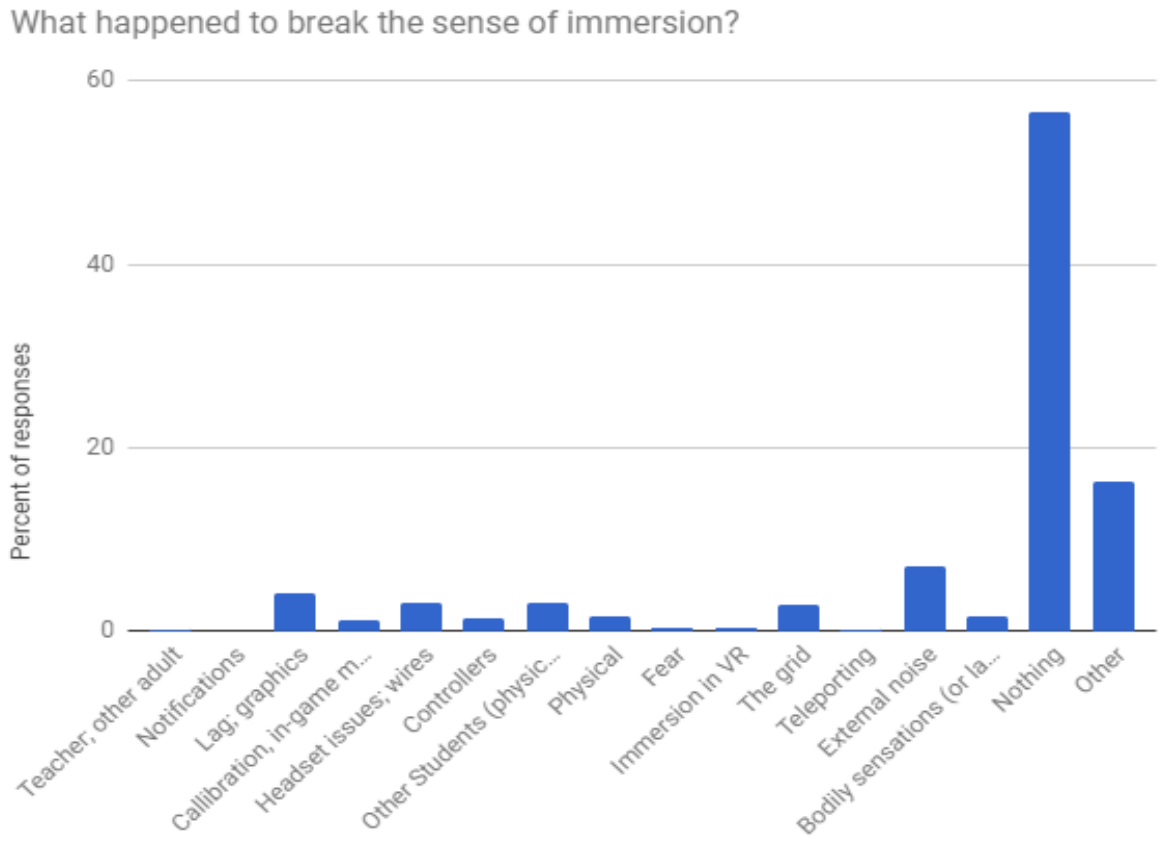


We were also intrigued by student impressions of the capabilities of VR. Students are often quick to offer thoughts on what could be better about a particular experience or the hardware itself. When we asked them whether or not VR content creators are considering the best applications of the technology, the responses were still largely positive, both pre and post. Again, we found the strong positive responses surprising given the strong opinions students expressed verbally and in writing about what could have been done better or how far VR still has to go. However, given that overall most students had very positive experiences in VR, it may be that they are feeling given the time commercial VR has been accessible to the general public that things it is trying to achieve are solid.



What breaks immersion

From our previous research in VR we heard from students, anecdotally, that because of the noise and distraction in schools, staying immersed in VR can be challenging. In this study, we specifically asked students to reflect on what breaks immersion in the classroom. Though items were distributed across the categories, external noise and visual lag were the two most prevalent.



The great value of virtual reality in education is the immersive qualities. In academic settings, where many students are interacting together, it is important for educators to take steps to ensure that the immersive qualities are not lost. Effectively setting up the environment for successful immersion takes place prior to the student ever putting on the headset. Our research shows that external distraction from other students, including touching or laughing, clearly breaks the immersive experience for other kids. Though we do know that the initial uncomfortable laughter that adolescents go through upon first using VR headsets diminishes over time, it is essential that teachers set ground rules for appropriate and inappropriate behavior of students outside of VR is addressed. It is imperative for students' safety and emotional well-being that they never be touched while they cannot see the real world and are immersed in VR. Nearly all of the schools we worked with set rules for ensuring that the only reason another student should touch an immersed student is if they are going to bump into something.

We also know that in school settings where bells, announcements, and a roomful of other people are present, audio is a key component of the immersive experience. Teachers who used decent headphones found that students had much more positive immersive experiences. Teachers who did not use headphones at all had students who expressed that they felt less immersed in the virtual environments.

Types of Content that Helped Students Feel Immersed

We asked students to reflect on types of content that they found particularly immersive and it is interesting to note that the vast majority of experiences that felt immersive were those that included interaction on the part of the student. Art experiences where they were creating and action experiences where they were able to move around and impact the trajectory of objects or events were among the most immersive to students.

In addition to those with direct action, students also felt immersed in place-based experiences (*Google Earth, Grand Canyon Simulator)* where they actually felt like they were visiting a different locale. History was another strong choice in the immersive category (with specific references to a King Tut experience and Pearl Harbor) because they enjoyed the time travel aspect of it.

There was also a solid amount of references to immersive experiences that fell into the categories of scary games and interactive games. For the frightening experiences, students responded to physiological sensations as a result of the experience (my heart was racing; I could interact with the scary things; I felt like I was there). In the more game-based experiences (e.g., *Job Simulator*, which were often used to help introduce students to the VR environment) students again referenced the interactive ability and how they felt like they were no longer in school, but somewhere else.

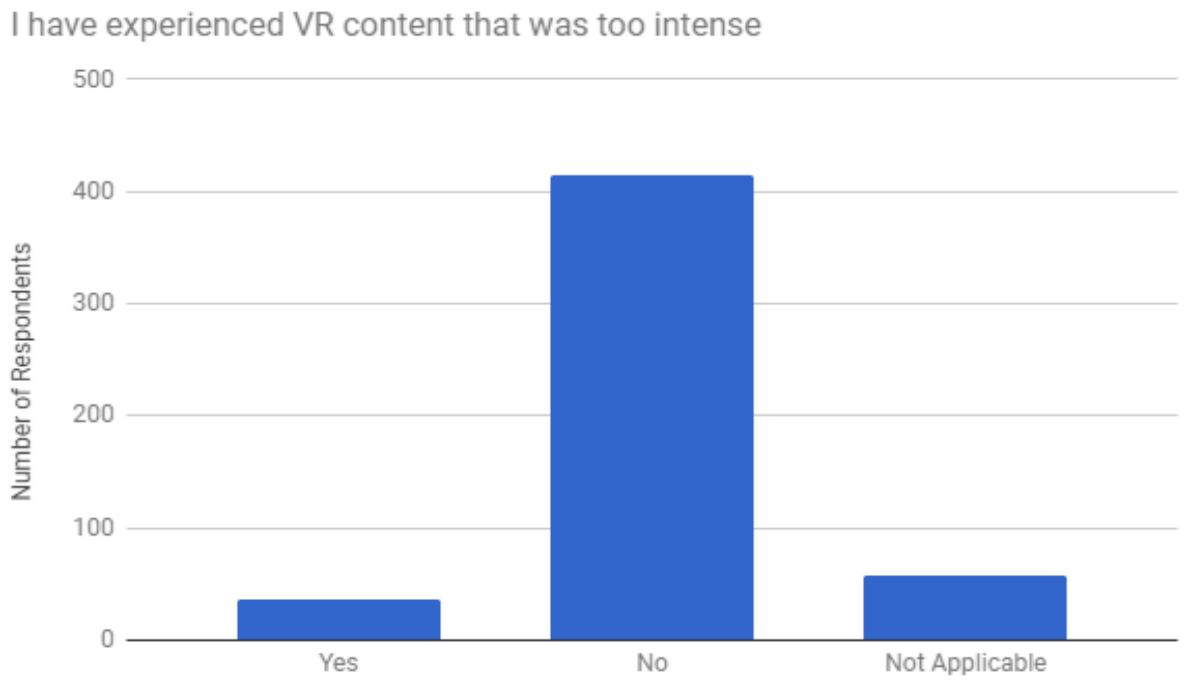
We also heard from many students about experiences involving underwater and space. Part of what made underwater and space interesting was the interaction between students' knowledge of the place they were seeing along with their lack of full understanding of that same place. For instance, they may have understood a whale is big, but seeing it scale properly in VR was a new experience. In space, they were surprised by how real the simulation looked and again referenced that space seemed much larger than they imagined.

The other large category that students mentioned highlighted experiences such as roller coaster simulations that played with their sense of motion and space. Interestingly, a number of students referenced a real-life fear of roller coasters and found VR to be a way to play around with something they were marginally afraid of in an environment where they knew it was not real. We know from psychological research that VR can be used to help people overcome phobias or address fears precisely because it is real, but not real, so it was interesting to see students play around with this idea on their own as well.

Intensity of VR content

One of our primary concerns with adolescents is how intense VR can be. We know from other work we have been doing in VR that even experiences that seem innocuous can be much more

intense when experienced in an immersive context. In this category, we only took post-responses from students and it is evident that the vast majority did not experience VR content that was too intense. However, it is also imperative to note that there were still about 40 students who did feel like they had experienced content that was too intense. Given the sample size on this question, that came out to approximately 7% percent of students who felt like it was too intense, a small percentage but still a distinct set of students. Better understanding what types of experiences seem too intense (e.g., is it the content? The motion? The size of the artifacts in the content?) and if there are ways to mediate that intensity will be important avenues to explore in future research.



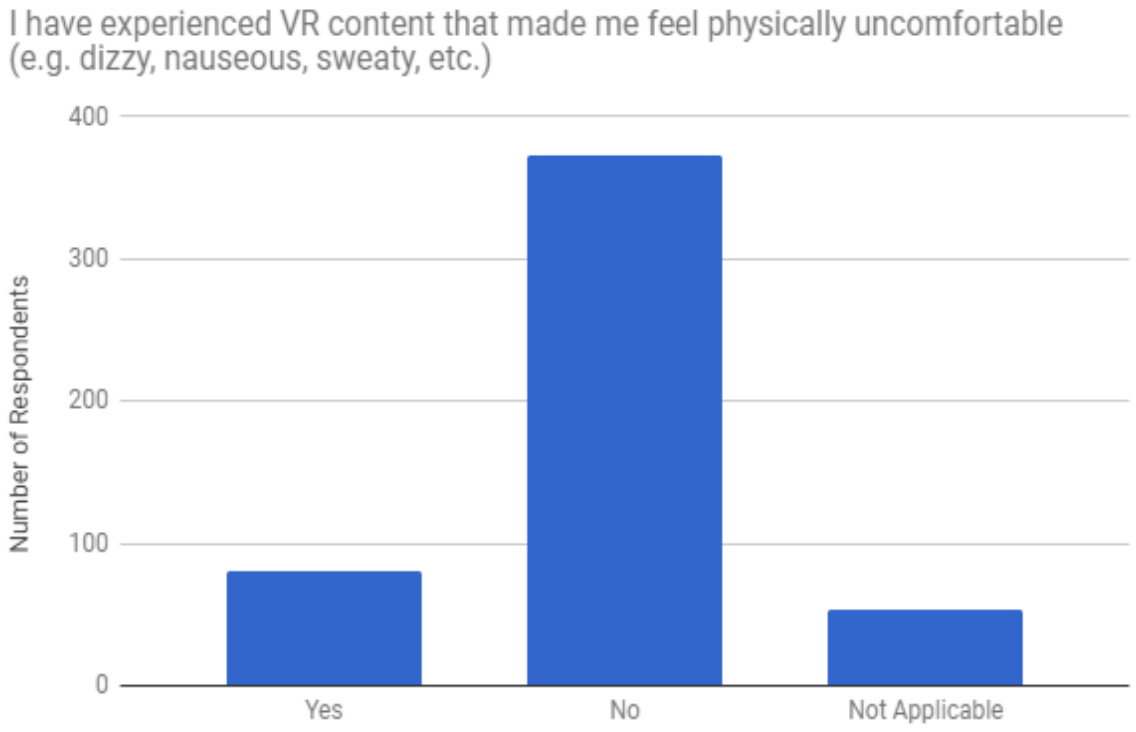
Of the 40 students who said they experienced content that was too intense for them, 24 said things felt too real and overwhelming, 19 said something in the experience scared them or brought out a phobia they have and 6 said things got too close to them. Even though this is a small subset of the folks who participated in VR, it is important to consider ways teachers could create classroom VR environments that mediate the level of intensity students feel while in VR experiences. We speak more to that point in the recommendation section at the end of this report.

Physical Discomfort

Another common concern that students express about VR, before trying it, are worries about nausea, dizziness, or headache. Though modern headsets are designed to eliminate or minimize those possible sensations, depending on content (and student physiology) they may still occur. It is notable that again, though the vast majority of students did not experience negative

physiological side effects, there were 81 students who did, which represents 16% of the sample on this question.

Again, the range of responses could be from “sweaty” to “ill” and it is also important to note that several classes tried experiences for fun that involved roller coasters, flying, or scary games. These are significantly more likely to induce physiological responses, particularly those involving motion. Things that are likely to cause illness in VR are related to the frame rate of the images (which is a technical issue that developers grapple with and are getting very good at minimizing) and the disconnect when the inner ear recognizes a person is “not moving” but the user feels like they are moving in VR. It is important for the teacher to be aware of the types of content students are exploring and to explicitly state when a piece of content involves motion that may be disturbing.

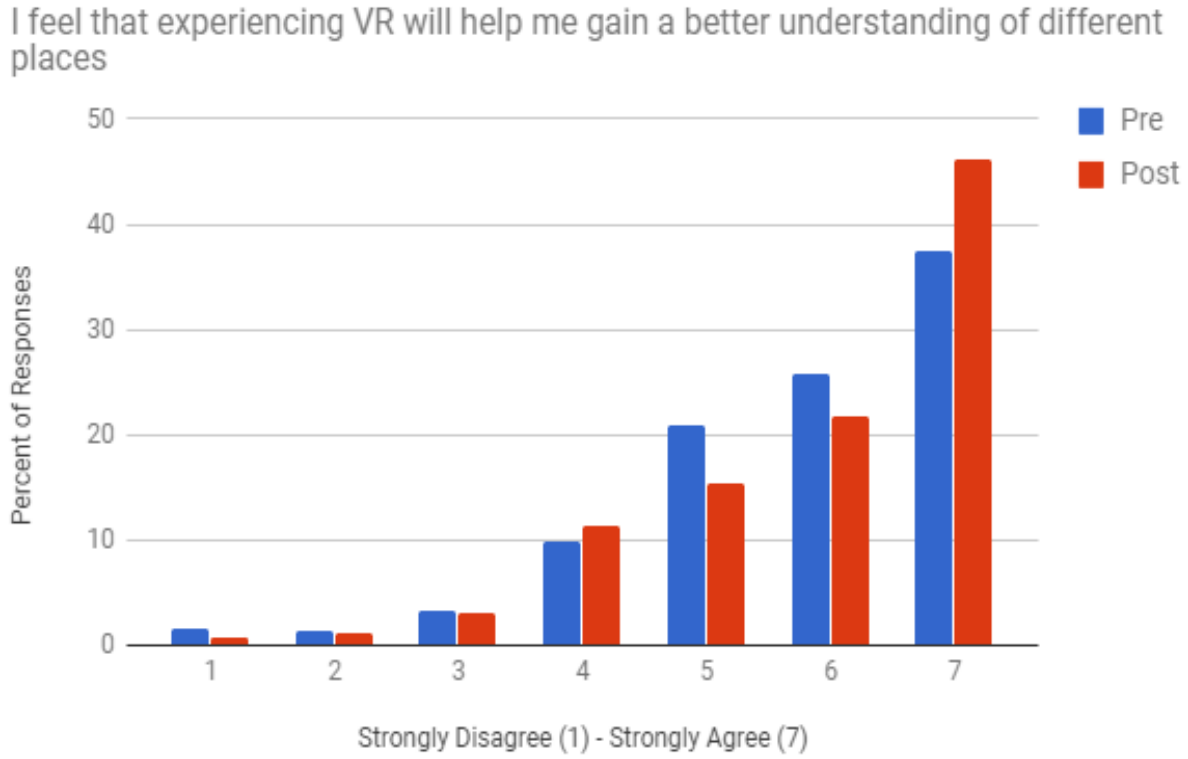


Understanding Different Places and People

Some of the appeal of VR emanates from the idea that it will be a helpful tool for empathy. In order to begin to address whether or not students were in fact framing VR as a tool for understanding, we asked them to consider two things: (1) Whether VR would help them to gain a better understanding of different places and (2) Whether VR would help them to gain a better

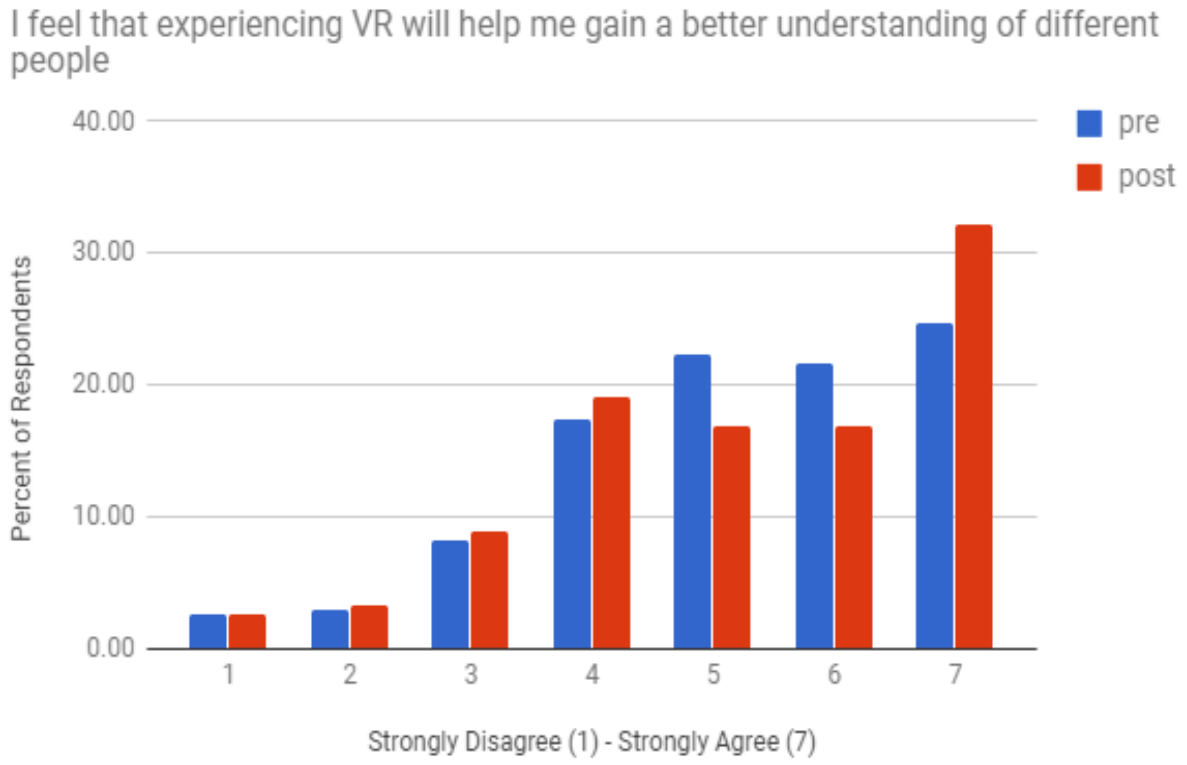
understanding of different people. From our discussions with students in 2015-2016, we decided to separate the two out because we found that answers became conflated and students considered people and places differently.

As seen below, in the pre-surveys students felt that VR had the potential to help them understand different places. What is interesting to note is the shift over time. The number of students who strongly agreed with that statement increased nearly 10% from pre to post. There was some slight shuffling in the intermediary categories from pre to post, but amongst the students who strongly disagreed, we saw a decrease in their strong disagreement from pre to post. These findings suggest to us that students see potential in VR, after having repeated exposure to it, as a tool to better understand different places.



Even more interesting was the difference in the students' perceptions of whether or not VR would help them gain a better understanding of different people. As can be seen below, students were generally a bit less sure that VR would enable them to understand different people. In the post responses, though there was an increase of almost 10% in the strongly agree category, it is notable that the results are much more distributed across the entire agree/disagree spectrum, and, in fact, there were slight increases in two of the disagreement categories as well as the neutral category, so there is a shift towards the negative. These results suggest that how students conceptualize relating to other people through VR may not be as definitive as we think and the idea that VR might really help us understand other people might not be as clear cut as we imagine it to be.

Additional work exploring the contexts and ways in which we can increase understandings of other people in educational environments is a worthwhile endeavor. Anecdotally, we have seen examples in some classrooms where teachers integrated VR experiences with people alongside curriculum that enabled students to engage with "real" people (e.g., having students connect with actual refugees in addition to viewing a refugee piece of VR content). It is an intriguing idea to explore the ways in which we can present students with scenarios that involve a mixture of real and virtual experiences to help better understand a variety of different people.



Open Student Responses

At the end of the survey we allowed students to tell us about anything they felt was relevant that we did not ask. Though we will not address all comments here, we will highlight a few categories that came up a repeated number of times.

The first is that many students felt that VR should be made widely accessible to more students. They felt other classes, schools and kids should have the opportunity to engage with it (and, in fact, we heard this enough from kids that we expanded our 2017-2018 study to include a larger number of schools and a wider demographic group). Students felt VR had great potential to help people, in general, whether with future career paths, anxiety, world-exposure and just hopes that it could help more people feel successful.

Many students referenced the hardware, specifically the cords. There were many requests to make it wireless or to have their teachers alter the set-ups so that kids were less likely to trip over the wires or bump into things within the classroom. We saw a great set-up in one classroom where a teacher literally used a rug to demarcate the VR area and students knew to not step or put anything within the rug space.

Students appeared to enjoy doing the surveys and many of them made positive comments about their instructors, the study and talked about being able to share their opinions. Many hoped their opinions would be used to help other students and teachers.

Overall Recommendations

This year's study supports the findings from previous years with regard to VR being perceived as an interesting tool for learning. Based on responses from this year, we would like to dig more deeply into whether or not there is differential value in using VR versus other technologies or activities in traditional classrooms so that students are asked to think comparatively. Below are some of the key findings we identified from this year's data set.

First Time Teachers and Community Support

Though this was the second year of the study, we had added many new schools, and part of what we recognized is that there is a large difference between first year and second year VR implementation. It takes several months for teachers to feel comfortable with the equipment, and familiar with content and student routines. That first year is often used as an exploratory time with content that can be easily added to an existing curriculum. Teachers who are experiencing VR for the second year understand how to get it up and running, and have often spent additional time and energy thinking about content and how to further integrate the virtual experience and they are more comfortable with elaborate lessons. Because of the learning curve, both in the pedagogical sense as well as the technological sense, we feel is extremely important for teachers to have strong IT support as well as administrative interest. Those teachers who had both encountered less difficulty setting up their systems, felt like there was help available when needed, felt more connected to their schools, and felt supported and enthusiastic about implementing VR. When administrative or technological support was lacking, teachers felt that VR was a burden and even if they had enthusiasm, it waned when they were unable to overcome technological challenges.

On a positive note, even teachers who did not consider themselves tech-savvy were enthused enough about VR to work through many of their technological challenges. This was something we were concerned about upon bringing VR into non-tech classes. Most of the teachers in the study found that they were actually connecting with other teachers and students more as a result of the implementation of VR. It gave them reasons to invite people in and to share what their students were doing and thus helped to build community within the school. In schools where more than one teacher was engaged with VR, teachers were better able to plan and brainstorm, however, even without another teacher in the same school with VR, many schools found ways to

connect teachers with other educators who were using VR, and that type of community was found to be an effective way to provide support for teachers.

Content Warnings

We would like to state again how important it is that teachers test out content and let students know about possible trigger warnings prior to having them engage with VR content. One of the fascinating aspects of the immersive qualities of VR is that it can really make people feel as though they are somewhere else experiencing something first-hand. The trick for educators is that sometimes something might not seem like it would be a "trigger" for a student (e.g., going underwater, seeing a virtual robot) but they may indeed cause distress.

Some teachers worry about ruining the surprise of an experience by giving students too much information. We find that by letting students know key elements such as, "This is an experience that will take you underwater, in an enclosed space and you may see creatures" or "This is an experience that will expose you to high places with edges" many triggering situations are avoided. Often students can read a short description or even see a preview of some VR content. With the advanced VR headsets, it is extremely helpful that they can be projected onto a computer screen so that students not in the immersive experience can check it out without being completely immersed.

It is important to note that even with less-immersive experiences, such as Google Cardboard, the same ideas hold true in terms of trigger warnings. Though they are less-immersive, in many cases, there is actually a wider range of content for headsets like Cardboard and it requires more discretion on the teacher's part. Sometimes students don't think that something will be scary or unnerving until they try it.

As always, students should have the option to not be immersed, to do an alternate activity, or to remove the headset at any time if they feel uncomfortable. At the present time, VR content is not rated the way video games are rated. To our knowledge this is something that will be coming in the near future, but it is still important for teachers and students to use discretion and be thoughtful about how the different virtual experiences may be interpreted from students. All students come from different backgrounds and life-experiences, and we know from our research (as well as other VR research) that those individual differences do impact students' responses to content.

Situating Content within the Curriculum

One way to help avoid negative VR experiences and to actually help ensure that the VR experience has the desired outcome is to ensure that the content is well-situated within the curriculum. Students and teachers report the most positive experiences with VR when it is clear why they are using a particular piece of content and when they are able to debrief/discuss the experience afterwards. We know from research that even when an instructor thinks it is clear why a particular piece of content is being used, due to individual differences among students,

sometimes it is not clear at all why they are doing what they are doing or what they are supposed to take away from the experience.

One way to help this process is to use a small-group model of exposure. If a group of three students is rotating through a centers-based activity together, with some questions to answer or discuss post-immersion, they have the chance to engage in dialogue and debrief the experience. Further discussion or explicit connections from the teacher, again, help to further situate the experience so that is meaningful and memorable for the student.

For example, a Syrian Refugee VR experience will make more sense and have more value if a student has an understanding not only of geography and place, but also an idea or construct of what it means to be a refugee, context around how being a refugee might relate to them as an individual, and, if possible, pathways that connect to actual people so students can think about actionable ways to help. We have seen a few cases in classrooms where students used a virtual experience as a jumping off point for donating money or assisting with particular causes. In those cases, the VR experience was well-situated within the curriculum in ways that enabled students to feel empowered and connected, and though the VR portion may have been a key element in that, it wasn't the only factor.

The fact that students find "place" easier to understand than "people" is an interesting factor to consider when designing curriculum. We will do additional work in this area, but it seems that just "seeing people" in other situations in VR in a school setting may not lead directly to the type of understanding and empathy we might hope. Experimenting with ways to bolster the VR experience with explicit, concrete, external information may improve the likelihood that students will walk away with a clearer, more empathetic understanding of other people.

Immersion in Schools

When students feel immersed in a virtual experience it leads to feelings of presence, of "being there" versus being in the classroom. Though the advanced VR headsets are able to show high quality graphics, and have a wide-viewing angle and high frame-rates (which reduce feelings of nausea), the visual aspect is only one element that factors into students really feeling immersed in their virtual worlds in school.

One of the main complaints students had about immersion was that when there was too tight of a limit on time for VR usage; they could not get into it. In one classroom, students were only given 90 seconds at a time before they had to pass the headset to someone else. That did not give the individual in the headset enough time to situate themselves within the virtual space and establish a sense of presence, they felt pressured because they knew their time was so limited. We know that part of the reason the small group approach to advanced VR works is that students have a chance to explore and don't feel rushed. It breaks immersion when a student outside the experience is constantly reminding the person in the experience that they have only have 3 minutes left.

This consideration of time in VR is especially important for students who are creating. In one art class we visited, students were given as much time as needed to create in the virtual space

because the teacher divided up VR time so that two students per period could go into *Tilt Brush*. It spread the project out over several weeks, but students were also working on other projects during this time so that VR was just one of several ways to engage with art. Students expressed satisfaction at not being rushed.

Sound is also a vital element in immersion, particularly in school settings. Teachers who provided quality headphones to students had them feel more immersed and present in the VR experience. One teacher did not want students to wear headphones so that the kids could easily hear the teacher's voice when needed. This sensory input from two different sources, in the VR headset and outside the classroom, served to distract students from both environments leading to a reduction in the quality of experience with VR. Students who have quality audio experiences with VR are able to move away from the classroom setting and engage fully in the content they are seeing.

The other major consideration in immersion in classrooms has to do with the ground rules the individual teacher sets up. We knew from the 2015-2016 study that this was important and it was strongly echoed this year as well. Nearly all the teachers say that no touching of people in VR is allowed. This year, students commented that if other students were near them laughing or being silly, even if they weren't being touched, it was distracting enough to make them self-conscious about being immersed. Establishing what is acceptable and not acceptable behavior while people are immersed in VR in a classroom is an essential piece of helping students feel safe enough to truly be present in VR.

We also learned that there are some small things, such as placing a mirror near where the headset is stored can help students feel less self-conscious when they come out of VR. It may sound trivial, but for some students, being able to check their faces out to make sure they still looked OK after wearing the headset was the difference between them trying VR or not. This makes a lot of sense given the social/self focus that is so prominent during the middle and high school years.

Making Sure All Students Feel Like VR Can Be for Them

The final point we'd like to make is that in several schools VR was offered as an add-on or a choice activity. Some students selected it and some students didn't. On the surface, this approach seems fine and very grounded in student-voice. However, what we were surprised to discover upon further discussion with students was that there were many students who indeed wanted to try VR but did not feel it was for them, and thus did not try it, even when it was an open option.

Some reasons for this included:

- "I'm not sure how to set it up and I don't know if I can figure it out."
- "I don't know any of the games on it, and am embarrassed to ask for help."
- "I don't really understand what VR is...we didn't talk about it much in class."
- "I don't want to try it by myself."

We had some excellent conversations with teachers about these types of responses and we found that there are some straightforward ways to combat some of these hurdles:

- Providing a whole class introduction to VR followed by a small group exposure time
- Showing trailers from some of the better basic VR experiences, with varying levels of interactivity, so that students have a sense of what VR might entail and not feel overwhelmed with the controls
- Not putting students on the spot by placing them in VR in front of their peers, especially if they are first time VR users and are a bit uncertain
- As the teacher, making sure that a variety of students seem to be trying it. Again, not in the sense that everyone "has to" but more of a reflective, "Hmmm… it seems like nearly everyone who is using it is a boy. Perhaps I should directly ask the girls if they would like to try it."

In our visits to schools this year, we saw a wider range of students in the more non-tech based classes engage with VR than in the more tech-focused classes. We wonder if the expectations of having to "know how" to use the technology were lower in the non-tech classes and thus more students felt comfortable figuring it out versus thinking they should already know. Teachers mentioned anecdotally that, when they were able to get a wider range of students to try virtual reality, there also seemed to be a corresponding wider increase in the interest/understanding of the technology and what it was capable of doing. We are looking into this further in our next study and believe there may be some implications here for equity and technology usage. Finding ways to help students feel supported in their explorations of advanced technology is important and VR provides a great platform in which to do this.

Next Steps

For the upcoming 2017-2018 school year, our research questions are informed by the student responses and comments from the second year of the study. We will be focusing both on VR and technology usage more generally. We will examine student interest in technology, the access routes they utilize to engage with varying forms of it, their use of VR as an emerging technology and we will focus on subject-specific areas of VR integration (art, foreign language, social studies/language arts, tech classes and science/math). The questions this coming year are more refined and again based on the perceived value of an emerging technology to both students and teachers in the classroom. As always, we do not dictate the hardware selected by the teacher, but we will provide VR setups to new schools joining the study as well as a stipend for content. Returning schools will receive an additional content stipend. Teachers select all of their own content to ensure that it is a good match for their curriculum and course objectives.

Our study design will remain nearly consistent to the previous iterations. Students in schools will complete a pre/post survey online for the course in which they use virtual reality. Teachers will complete three interviews, pre/mid/post about their use of the technology. A new element that we hope to add is a group, informal discussion with students during our visit to the school (we try to visit each school one time during the school year) to chat about some of the findings and to hear

students' voices with regard to virtual reality in their classrooms. As always, all data will be available to the school and teacher. Finally, as in previous iterations, foundry10 will work to assist teachers as they get VR up and running and will provide curricular support/suggestions if needed.

We currently have over 30 classrooms enrolled in the next iteration. We also continue to do work with VR in more controlled experimental contexts and are very interested in further exploring ideas identified in the 2016-2017 study as well.