Teaching Creative Design in Virtual Reality: A Course Designed and Taught by Students, for Students

Deniz Yaralioglu, University of California, Santa Cruz

Deniz Yaralioglu is a third-year Computer Science undergraduate at the University of California, Santa Cruz. Deniz was a previous student in Creative Design in Virtual Reality, where he realized his passion for crafting engaging and interactive virtual environments. After completing the course, he joined the First-Year Design program as a student instructor. In this role, he aimed to streamline the curriculum and introduce industry-standard tools that students could use if they chose to pursue a career in VR design. Outside of the classroom, Deniz enjoys going on hikes, playing video games, and spending time on the beach.

Yuhui Wang, University of California, Santa Cruz

Samantha (Yuhui) Wang is a third-year Physics undergraduate at the University of California, Santa Cruz. Her personal academic interest in optics drew her to UCSC's Social and Emotional Technologies VR lab for research in her first year on campus and she has worked to expand students' access to Virtual Reality at the university ever since. She believes technology is a tool to support a community and VR, being a new and emerging field, has a lot of potential applications that students can build upon. She is one of the original instructional designers for Introduction to Creative Design in VR and has since taught the course four times, each with the purpose of drawing on student creativity to expand on the use of VR. She continues teaching because the students' enthusiasm feels rewarding every time.

Kelly Lin, University of California, Santa Cruz

Kelly Lin is a recent Computer Science graduate from the University of California, Santa Cruz. During her time at UCSC, she served as a Student Instructor for two years, supporting and mentoring students through hands-on, project-based learning experiences. Alongside teaching, she took initiative to build a VR community on campus, aiming to make immersive technology more approachable and accessible to students. She also contributed to research as a Virtual Reality Research Assistant in the Social Emotional Technology Lab at UCSC, where she explored the intersection of immersive technology and human-centered design. Currently, she works as a Software Engineer at Ally Financial, where she continues to grow her technical skills and apply their academic experiences to real-world solutions. In her free time, she enjoys swimming and exploring new places.

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Tela Favaloro is an associate teaching professor for the Baskin School of Engineering at UCSC where she works to establish holistic interdisciplinary programming centered in experiential learning. Her Ph.D is in Electrical Engineering with emphasis in the design and fabrication of laboratory apparatus and techniques for electro-thermal characterization of sustainable power systems as well as the design of learner-centered experiential curriculum. She is currently working to develop an inclusion-centered first-year engineering program in hands on design and problem-based learning to better support students as they enter the engineering fields.

Teaching Creative Design in Virtual Reality: A Course Designed and Taught by Students

Introduction

There's an ancient Chinese idiom that states, "if there are three people walking, at least one person can teach me something new." The authors see this philosophy as underpinning the Lead By Design and First Year Design Experiences program, our School of Engineering's solution to create more accessible and experiential Design-Build curricula for first-year students [1, 2, 3]. Here, a group of knowledgeable and skilled undergraduate students can form a team to design and create new First Year Design course content on a subject matter that they are passionate about, and feel is underrepresented in the engineering curriculum. Not only do they take control of early engineering course content, but they also teach it as a formal, for-credit (graded) class. The subject of each First Year Design class varies with the undergraduate teaching team, often covering emerging technologies or skills typically inaccessible to early undergraduate learners due to a long chain of complex prerequisites or, in many cases, these topics are simply unavailable at many universities. Undergraduate student-teaching teams accepted to the program first enroll in the quarter-long Lead By Design to design their curriculum while practicing active-learning pedagogy, using backwards design to develop their course content around their proposed culminating Design-Build experience [3]. After successfully building or refining a First Year Design, these undergraduate teaching teams are hired as student-instructors, creating a cycle where former learners can later become student-instructors and mentor a new generation of engineering leadership. Details about the application-based process for student teams to propose, design, and teach their First Year Design class under faculty supervision can be found in [2, 3].

As undergraduate STEM majors representing disciplines from within and outside of our university's School of Engineering, the authors of this paper identify areas for improvement in our curriculum. Chief among these–from our point of view–is the lack of active, collaborative learning in most of our classes, likely due to 1) large classroom numbers discouraging collegial learning, and 2) students being encouraged to see peers as competition. Without interpersonal relationships and exciting projects to look forward to, classes can feel monotonous and disengaging, reducing students' motivation to participate or even show up to class. At our university, most early classes are lecture-heavy; the only opportunities to engage with the content and other learners often being homework assignments. The usual one-size-fits-all approach to teaching has led to students feeling disconnected from the material, increasing feelings of imposter syndrome and "burnout," a sentiment confirmed in the literature [4, 5]. It also disproportionately affects minoritized learners [6, 7, 8]. Many students are intimidated to seek support outside of lectures, compounding feelings of isolation and disengagement [7, 8].

We, the student-teaching team, see that it is necessary to foster community in the classroom by shifting away from didactic teaching methods toward more structured practice punctuated with collaborative learning opportunities. This way, universities can create a more supportive learning environment, one that encourages student participation and deeper understanding and leads to long-term success. Studies have shown that integrating active learning and hands-on experience with emerging technologies such as Virtual Reality can address many of these recognized issues. Unboxing new technology bridges the gap between technical knowledge and real-world applicable skills, allowing learners to be more engaged, especially when it's technology they encounter regularly in their daily lives [9,10]. By transitioning from passive consumption to active creation, we set students up to understand the underlying design principles that govern these technologies.

Our curricular strategy equips learners with a strong foundation of skills and knowledge through structured practice with iterative, goal-oriented learning tasks. This approach, when grounded in inclusivity and ownership, introduces learners to new technology in a way that encourages experimentation, prototyping, and innovation. By collaboratively creating artifacts with personal meaning in a low-stakes environment, learners gain confidence in their ability to tackle challenges, recover from failure, and solve problems. These collaborations also foster friendships; we have noticed our students are starting to hold each other accountable as they get more comfortable, encouraging each other to come to class so they have a friend to work with. As shown in literature, such an environment fosters individual growth when combined with encouraging and targeted feedback from the student-instructors [11].

Our teaching team identified the creative design of Virtual Reality (VR) applications as a topic that is a strong candidate to support collaborative and experiential learning in a manner that is accessible to early undergraduate students from many disciplines. Many students are already using virtual reality technology in recreational contexts, yet it is absent in many university curricula. From a survey of ten universities that together form a consortium of public research institutions across the state, of which our university is one, we found there are a total of 13 classes that have a VR focus [12]. Of these courses, 2 are graduate courses, 7 are upper division undergraduate with significant prerequisites or are limited to STEM majors, and 3 courses are offered through online extension and either have significant costs or require you to have your own headset. Only one course, our course, is available for lower division undergraduate students without prerequisite knowledge or cost.

Our class, *Introduction to Creative Design in Virtual Reality*, is a low-stakes environment where lower-division students, both STEM and non-STEM, are together able to explore the engineering design cycle, getting a glimpse into what it means to be an engineer. We demystify VR technology by focusing on the creative development of software rather than a purely technical lens to achieve *our goal* of building a more engaging, inclusive, and collaborative learning environment. Students from diverse backgrounds, particularly non-STEM majors, can bring their unique perspectives to VR design, enriching the field with their experiences in a way that is not possible in these other VR courses with restricted enrollment. In this environment, students work collaboratively through the iterative process of problem definition, brainstorming, prototyping, testing, and refining, building skills such as critical thinking, adaptability, and teamwork - all skills that are transferable to any career.

In this proceeding, we dive deeper into the structure of this class, designed to guide students toward creating a functional VR application prototype within a single quarter through technical implementation and creative exploration. We then survey the technical set up of VR headsets to provide an example of how the technology may be used in the classroom. Finally, we discuss qualitative and quantitative data collected from students and student-teachers over four offerings of this student-run class that affirm our findings - that this course is a more accessible pathway to engineering design.

A student-instructor's motivation for developing and teaching Intro to Creative Design in VR

Kelly Lin - 3rd year Computer Science undergraduate My interest in VR began at the Oculus Connect event, where I experienced the Oculus Go and was fascinated by its immersive potential. In college, I joined the [univ] Social and Emotional Technologies Lab, working on a project using VR to visualize and mitigate wildfire impact. This showed me how VR could go beyond entertainment to solve real-world problems. I also explored tools like ShapesXR, which led me and fellow students to develop our First Year Design, a course teaching interactive VR design. Noticing that many students hadn't experienced VR, we aimed to build a VR community at our school. Now, having taught this course four times, I'm passionate about helping students explore VR as a creative and impactful technology.

Sam Yuhui Wang - 3rd Year Physics undergraduate I joined a research lab that used VR in my first year of college and wanted to expand students' access to VR in the university. I believe that technology is a tool to build a community and VR, being a new and emerging field, has a lot of potential applications that students can build upon. I designed the course and have since taught it four times, including its first offering with the purpose of drawing on student creativity to expand on the use of VR. What keeps me teaching is the high-level of enthusiasm from students.

Deniz Yaralioglu - 3rd Year Computer Science undergraduate I took the initial Winter '24 offering of this class as a student and immediately fell in love with its premise. Coming into the course, I noticed a lack of VR-focused classes at our school, and this class filled that gap in a meaningful way. What stood out to me was that it didn't just teach the basics of being in VR; it also introduced industry-standard practices that could directly prepare students for careers in this emerging field. This focus on VR industry felt incredibly unique and forward-thinking, especially given how new VR is as a medium. Teaching this class has been a way for me to share the excitement I felt as a student and help others learn the potential of VR. I love hearing about the fun experiences students have in VR, especially those who have never had the opportunity to use a VR headset before this class. Seeing students stretch their creative boundaries and bring their ideas to life has been one of the most rewarding parts of this experience.

Course Design: Building towards a culminating design-build experience

As student-instructors, our vision for our class *Introduction to Creative Design in Virtual Reality* is to position learners to build a VR app of their own design within one quarter of learning, with no prerequisite knowledge. Thus, to be successful, learners would need to develop proficiency in the following key learning outcomes (the full list is further expanded in Figure 1):

- Mastering the safe use of VR headsets and navigation of VR space
- Analyzing and applying User Experience design principles in VR apps
- Constructing, modeling, and rendering 3D assets using Blender
- Modeling environments directly in VR using the ShapesXR app
- Storyboarding to visually articulate ideas
- Prototyping, peer-testing, and iterating designs based on user feedback
- Exploring VR performance optimizations to gain practical experience with iterative development.

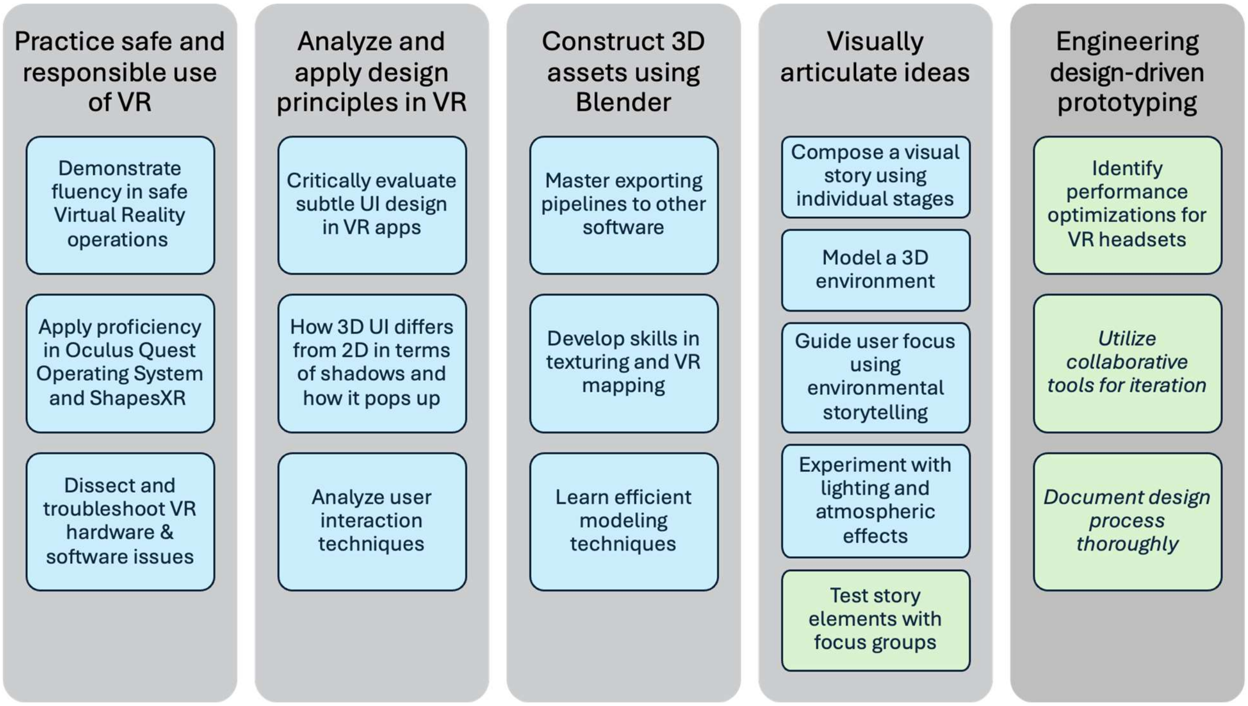


Figure 1: Learning outcomes of the student-developed and taught Creative Design in Virtual Reality class. Items in the table labeled in blue describe the technical learning outcomes of this class while those labeled in green are more focused in the engineering design process applied to app design. Note that italicized outcomes are general to all First Year Design Experiences classes that are part of this program.

Course Structure & Progression

Intro to Creative Design in Virtual Reality is a 3-unit course (~9 work-hours/week) that runs over a single, ten-week quarter, accessible to first year students without prerequisites. We designed a scaffolded learning flow (depicted in Figure 2) to ensure each learning outcome progressively builds in complexity toward the Culminating Project, which showcases learners' achievement of *advanced* proficiency in: VR usage, asset creation, and modeling virtual environments. The quarter is punctuated by the following phases, where the level of scaffolding fades every few weeks, bolstering learners' confidence and autonomy.

1. **Getting to know Blender & Safe VR**. The quarter begins heavily scaffolded, with learners mirroring the student-instructors' process of modeling 3D assets in Blender, providing a framework to ease into this new User Interface so that learners may focus on Blender mechanics and its tools. Concurrently, learners begin to navigate VR technology in a supportive and safe way in *spotter training* pairs to become troubleshooting partners while ensuring safety within physical boundaries (more details can be found below).
2. **Intermediate Blender as Art & Intro to Immersive VR design**. In the next phase, learners begin creating VR environments in ShapesXR and engage in intermediate Blender modeling activities, while shifting toward more independent use of VR. Learners analyze art's intentionality, exploring symbolism, user perception, and design choices, becoming deliberate about visual elements like lighting and scale in their own VR projects. The class activities in phase 2 focus on learners developing a user-centered approach, culminating in an immersive Art Gallery project where students showcase their art in VR.

3. **Interactive VR design**. In phase 3, learners transition from building passive VR environments to designing an interactive environment that surrounds and engages the user. Learners use storyboarding to thoroughly plan interactions before their implementation in ShapesXR. In the classroom, we explore subtleties in game design and interaction by unpacking the intuitive navigation, feedback mechanisms, and environmental cues from students' past experiences in games to make them both functional and immersive.
4. **Culminating Project: Team App Design**. This final project serves as the crowning design experience of the course, allowing students to collaboratively apply their now advanced Blender, ShapesXR, and VR skills with complete autonomy over how they are used. Student-teams create a complex, immersive prototype of a VR app from the ground up on a topic of their choosing. In line with the strategy of fading all scaffolding, this final phase emphasizes independence from the teaching team. Feedback becomes more community-driven; one key feature of this phase is a series of peer-testing sessions where learners present their prototype to fellow classmates, simulating real-world stakeholder interaction. The phase concludes with teams presenting their app concepts and classmates evaluating each other's prototypes in VR, bridging creative design with real-world communication skills.

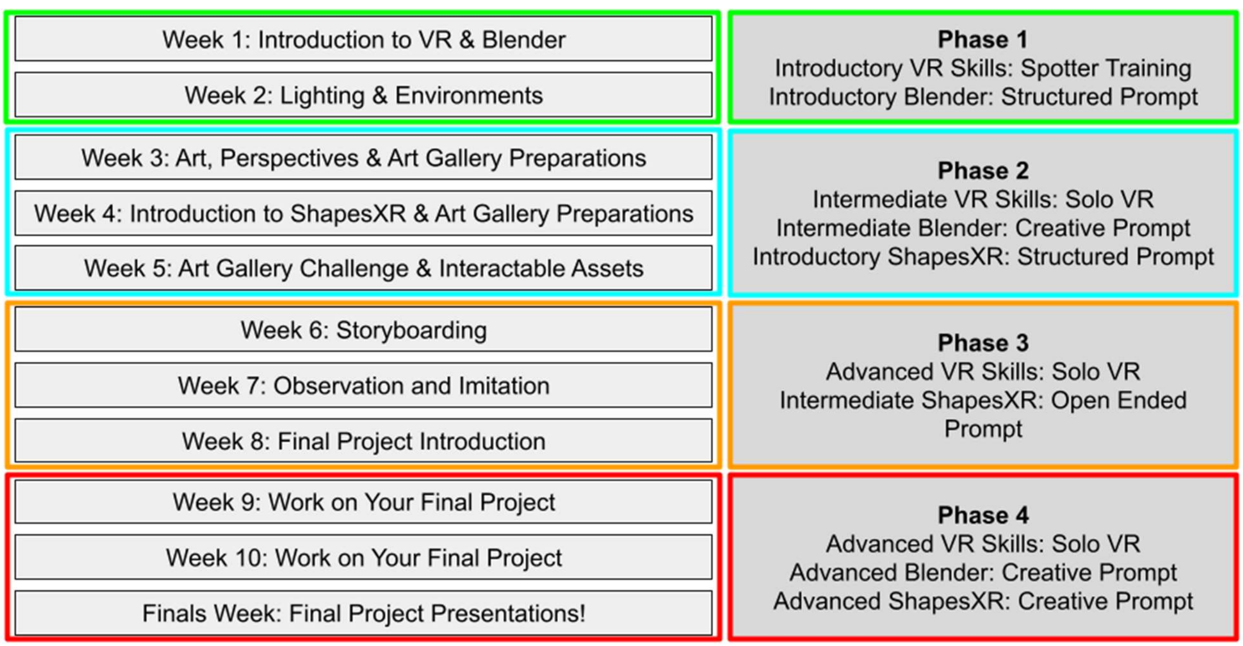


Figure 2: The ten-week course flow of Introduction to Creative Design in Virtual Reality. The headers on the left convey the theme for each weekly module as part of a scaffolding 'phase' depicted on the right. Learners transition across these four phases of the class, where each one provides gradually more autonomy until the final project phase where learners have complete ownership of their learning process and the VR prototype they develop, which are presented and celebrated during finals week.

Week by Week: A High-Structure framework for advanced skill development

Our class is structured into 10 weekly modules, each focusing on 1-2 core topics that either introduce a new skill or advance competency in a previously introduced skill. By breaking the material into manageable segments, students can focus on mastering each topic while developing effective learning habits, without feeling overwhelmed. Each weekly module includes the following components [2], all accessible via the course's Learning Management System (LMS) for transparency and accessibility:

- An ***Overview*** outlining the learning objectives and expected outcomes for the week.
- ***Prelab*** assignment introducing topics for the week
- ***In-class active learning*** plus a mandatory open lab session
- ***Lab assignment*** that synthesizes the module's learning outcomes.

We wrote the modular structure to serve as a roadmap for students. Each module incrementally builds on the previous one, ensuring continuity and reinforcing prior knowledge as students advance. This system reinforces our active-learning model designed to transfer ownership of learning to the students; it integrates prelabs, in-class activities, and labs into a cohesive flow. We have seen that this approach ensures that students are not only prepared for the weekly objectives but also progressively develop the skills needed to achieve the final project. The list of weekly modules contextualized by phases is presented in Figure 2 above and an example module from our LMS can be found in Figure 3 below.

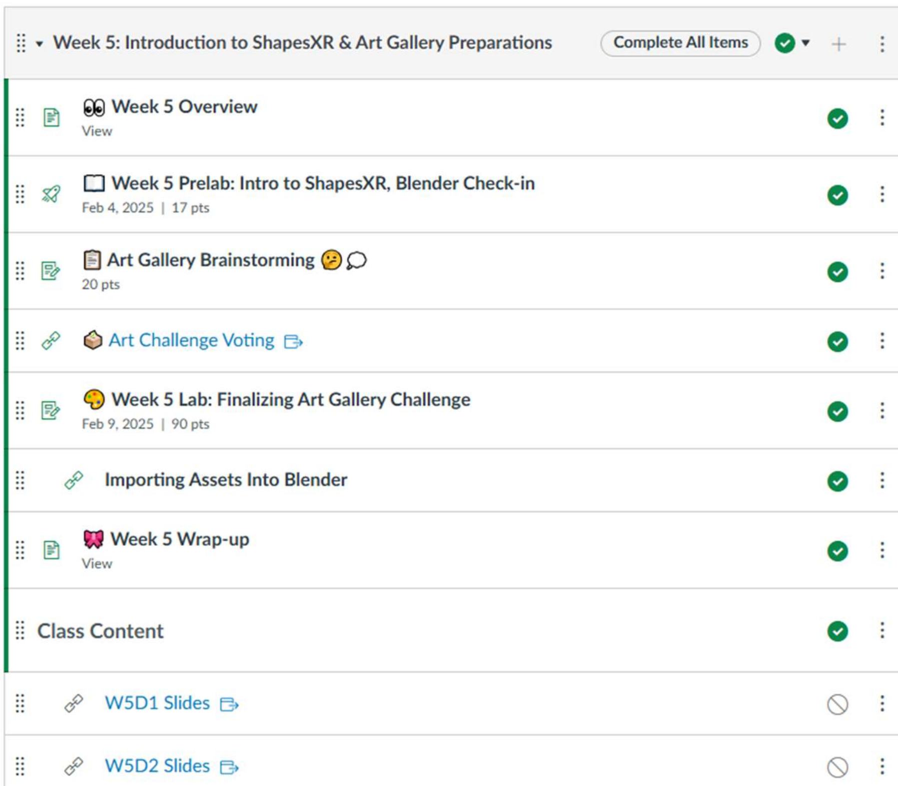


Figure 3: An example of a weekly module accessible to students in Canvas. The week of the midterm challenge gives a good example of the way each module is structured. Starting with an overview of the week, the students complete a prelab before participating in in-class activities followed by a lab, due at the end of the week. The prelab is a priming assignment that provides foundational information to prepare students to participate in class and then help students with their lab. The module ends with a wrap-up detailing what the students learned that week and links to the in-class slides.

Flipped Learning with ***Prelabs***:

We introduce each week's topics via a 'read and watch' prelab assignment to be completed before the start of the first class of the week. This approach shifts responsibility for acquiring foundational knowledge to the students outside of class, so we can reserve in-class time for more collaborative and fun activities. That way, everyone is building off the same foundation and is prepared to engage in in-class activities. Each prelab is concluded with a low-stakes quiz to ensure participation and to reinforce key learning objectives. For the instructors, the quiz informs us of any gaps in the curriculum. We always review the prelab materials in-class; students share their quiz responses and discuss their reasoning, fostering a communal learning environment and we can address any misconceptions. This process not only reinforces understanding but also boosts students' confidence in their knowledge before tackling the more collaborative and complex in-class activities.

For example, in the week leading up to the art gallery challenge, we assign a prelab where students read an excerpt from the book "Short Guide to Writing about Art" by Sylvan Barnet [13]. Then as part of the quiz, they use what they learned to analyze a piece of art through this lens. They also submit one of their favorite pieces of artwork for similar analysis and critique in class. We saw that prior exposure to the vocabulary around symbolism, intention, and audience perception in art allowed for increased participation in more nuanced discussions; learners were able to move beyond superficial critiques–such as dismissing contemporary art as "messy"– and delve into deeper meanings and context that shape an artwork's impact.

In-Class Collaborative and Active Learning:

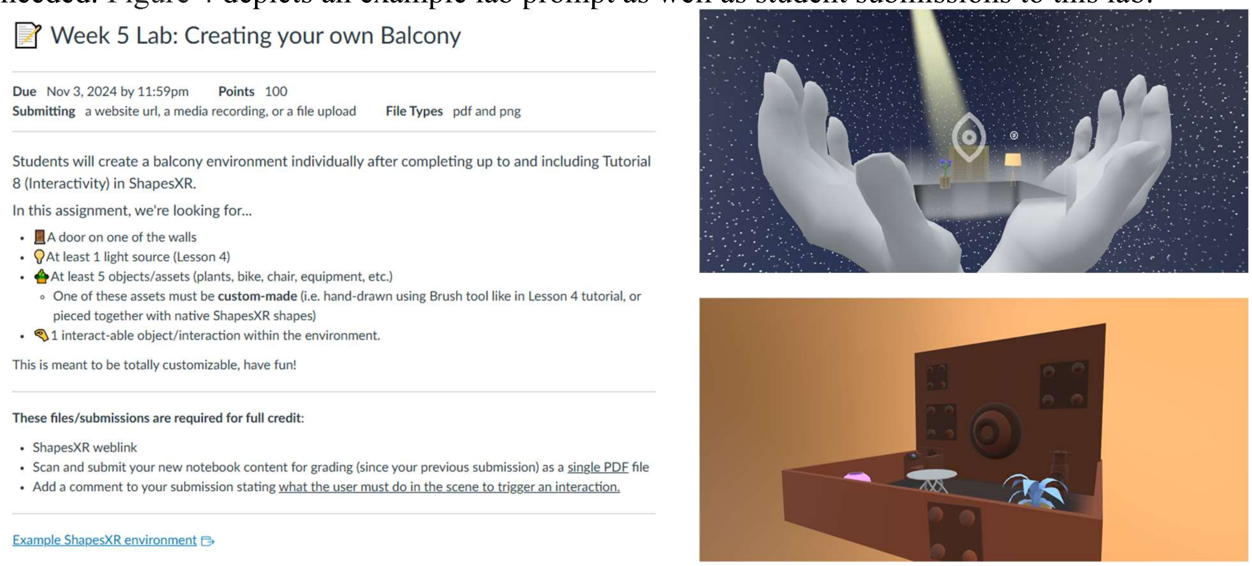
During class, we demonstrate and build on the prelab concepts in an active-learning setting, working to bridge the gap between prelab theory and more complex skill implementation in labs through collaborative learning. We use class time for short collaborative activities and challenges, demonstrations, reflections, and short lectures covering topics that are essential to user-centered VR app design such as lighting, UI, environments, and interactable assets. Additionally, we often reserve time for learners to enter VR and explore a particular application, noting the app's use of the concept taught in class. This hands-on and immersive exploration allows students to observe the practical applications of what they've learned, so they can later apply these design choices when working on that week's lab.

Our class is heavily based on collaboration among students; we use class and open lab sessions to facilitate teamwork since students' schedules often do not align outside of class. They may work on their collaborative projects together, bounce ideas off each other or get feedback from the whole class after pitching their project 'shark tank' style. To facilitate sharing their progress with VR, students can either invite their classmates into their ShapesXR collaborative workspace and show each other around while in VR, or they can opt to cast their headsets to a nearby computer, giving them more control over how their classmates experience their project.

As student-instructors, we find it really beneficial to use the think-pair-share technique to engage students in reflective processes around active learning. In our framing, the students first reflect on materials individually, formulating their thoughts without external influence. Next, they discuss their ideas with a peer, using vocabulary that builds their communication skills for future interdisciplinary works. Finally, they share their ideas in the classroom, taking ownership of their learning when they defend their viewpoints and listen to others. When considering others' perspectives, they also learn to consider other's experiences and emotional response. We find this process very valuable as it encourages learners to be personally invested in their learning, and thus we use it frequently to achieve a more interactive classroom.

Experiential Learning: ***Projects & Labs***

Weekly Labs are a vital component of our course; they provide opportunities to independently synthesize the concepts and skills learned during the week. Our labs serve as weekly design projects where students create tangible artifacts using the technical tools of the class: VR, ShapesXR, and Blender. We designed each weekly lab prompt to build students' confidence through iterative learning while also preparing them to tackle more advanced topics in the coming weeks. Labs also encourage focused tinkering or product-driven experimentation, where students showcase their creativity and problem-solving abilities while developing a polished and meaningful output. For instance, a student may experiment with different ways to optimize their 3D assets to improve their performance on their VR headset, progressing from practice to mastery. Each lab should take students ~4 hours each and are due at the end of the week, ensuring they have ample time to engage deeply with the material and attend open lab times as needed. Figure 4 depicts an example lab prompt as well as student submissions to this lab.


Week 5 Lab: Creating your own Balcony

Due Nov 3, 2024 by 11:59pm **Points** 100
Submitting a website url, a media recording, or a file upload **File Types** pdf and png

Students will create a balcony environment individually after completing up to and including Tutorial 8 (Interactivity) in ShapesXR.

In this assignment, we're looking for...

- A door on one of the walls
- At least 1 light source (Lesson 4)
- At least 5 objects/assets (plants, bike, chair, equipment, etc.)
  - One of these assets must be **custom-made** (i.e. hand-drawn using Brush tool like in Lesson 4 tutorial, or pieced together with native ShapesXR shapes)
- 1 interact-able object/interaction within the environment.

This is meant to be totally customizable, have fun!

These files/submissions are required for full credit:

- ShapesXR weblink
- Scan and submit your new notebook content for grading (since your previous submission) as a single PDF file
- Add a comment to your submission stating what the user must do in the scene to trigger an interaction.

Example ShapesXR environment

Figure 4: The prompt (left) and sample student submissions (right) for Lab 5, a lab in which students create a balcony space in ShapesXR using assets from the ShapesXR library.

Labs provide structured practice while acting as formative assessments with timely feedback, helping learners improve. When grading labs, the teaching team considers weekly learning goals, student progress, and past work to identify areas where support is needed. We also offer extra credit to students who take initiative, whether by exploring new tools or pushing their projects beyond the class material. This approach encourages curiosity, self-directed learning, and creative problem-solving, which are key skills in the ever-evolving field of VR.

Design Notebooks

Design (engineering) notebooks are introduced early in our curriculum, and we expect students to maintain them throughout the course. Required for all design-build classes, these notebooks are living documents that capture students' learning. When working on design projects, students use the notebook to brainstorm, sketch out ideas, work through challenges, and refine their designs in an iterative manner. Modeled after the engineering notebooks, this documentation practice familiarizes students with professional standards while instilling the habit of reflective and organized design thinking. Students are required to submit their scanned notebook content alongside their weekly lab submissions.

From our perspective, design notebooks offer a window into students' (meta)cognition. They reveal how learners approach problems, develop solutions, and iterate their ideas over time. We see their evolving understanding of the material and it helps us deliver targeted feedback during grading, address misconceptions proactively, and assess growth beyond deliverables. The iterative process ensures that the focus isn't solely on the final product but also on the design journey, encouraging students to value the process as much as the outcome. By the end of the course, students leave with a comprehensive record of their learning, which they can reference in future endeavors. We are often surprised by our students' creativity–whether it's using tools beyond our curriculum or an original concept–as they progress on the path to their final designs.

Preparing learners through industry-standard practices

Our curriculum emphasizes professional practices and user-centered design principles, especially through the course's key design experiences. Learners create *app information documents*, –modeled after the industry-standard product requirements document–to define their application's name, purpose, and target audience. They craft *user stories* to guide app development and *storyboard* key user interactions, ensuring their design addresses user needs while adopting structured development processes. The *asset manifest* is another essential tool for app development, where students catalogue assets, whether created in Blender or sourced from the internet, and note their interactions. It also serves as a planning tool for larger projects to organize workflows and track accountability, allowing their partner and the teaching team to better keep track of their progress. This practice encourages effective planning and collaboration, while also simplifying assessment. Together, these components expose students to user-centered practices and prepare them for continuing similar work in the real world.

Figure 5: Three student submissions to the art gallery project. Figure 5a (left), titled "My Bike," features a realistic mountain bike created in Blender, traversing terrain in a forest created in ShapesXR. Figure 5b (center) depicts "The Unknown Hero," an ode to Vasily Arkhipov. Figure 5c (right), "My Dearest," depicts a crochet plush ball that means a lot to the student.

Art Gallery Project

The midterm project for our class is a virtual art gallery, where each student creates unique artwork in Blender and uses ShapesXR to design a curated showroom, where they control the lighting, spatial scale, and the perspective in which their art is viewed. Their completed art installation is submitted as a *space* in ShapesXR, then stitched together into a larger virtual space by the teaching team to simulate an immersive art gallery, with rooms full of their own art installations that students can enter and explore. Students use this time to offer a critique of the work, analyzing its form, function, context and content, then vote for artwork to win a small prize in different categories, including the most colorful and most delicious. By giving students an open-ended prompt where they can showcase their creativity and personalize their work, they take ownership of the project while applying the technical skills they've developed. The virtual art gallery serves not only as a mid-term synthesis and assessment of their ability to use Blender and ShapesXR, but also as an opportunity for students to engage in a collaborative, immersive, and meaningful experience. Examples of students' artwork can be seen in Figure 5: Three student submissions to the art gallery project. Figure 5a (left), titled "My Bike," features a realistic mountain bike created in Blender, traversing terrain in a forest created in ShapesXR. Figure 5b (center) depicts "The Unknown Hero," an ode to Vasily Arkhipov. Figure 5c (right), "My Dearest," depicts a crochet plush ball that means a lot to the student.Figure 5 above.

Culminating Project

The culminating project, spanning multiple weeks, challenges student-pairs to collaboratively design, prototype, and pitch a VR application. Learners begin by brainstorming and conceptualizing their own app ideas, then they pair with a peer who had similar ideas to create an immersive prototype from the ground up. Pairs apply UX design principles throughout their app development process, through the creation of a user story and when crafting their storyboards. During this stage, learners consider the effects of lighting and scale and plan the user interactions they'll have available in their app (i.e. haptic feedback when the user grabs a tool). At this point, design-feedback-brainstorm iteration is critical; we plan multiple peer review sessions where student-teams present their prototype to fellow classmates and incorporate user feedback to refine their work, optimize performance, or fine-tune interactive mechanisms. During these collaborative sessions, students sometimes share newly released software features they discovered that expand our teaching-team's understanding of the tools.

Figure 6: Four snapshots of student-team submissions to the final project, where they are prompted to create an immersive VR application. Figure 6a (top left) is a scene from "Year 2037: The Drowned Civilization," where the user explores an underwater environment to find a key to enter the temple. Figure 6b (top right) shows the final level in "Fear and Feline," a Ramen restaurant run by a cat. Figure 6c (bottom left) depicts the restaurant game "Cook Time" where the user makes food for clients

using their magical ability to manipulate time. Figure 6d (bottom right) is an aerial view of the forest in "Slug Life," a game where you play as a slug exploring the [local] forests.

The final project phase culminates during the final exam period with each pair delivering an app "sales pitch" to their classmates. Although informal, the setting provides learners with an opportunity to practice their communication skills, bridging the creative game design element with the practical demands of stakeholder engagement. After each team presents their 'app info,' their classmates immerse themselves in VR to experience the different prototypes, offering their final peer evaluation. Snapshots from three student submissions can be seen in Figure 6 above.

The final project showcases the learners' achievement of the technical and professional skills taught in this class, namely, advanced modeling and environment design with Blender and ShapesXR. Summative assessments, conducted by the instructor-of-record, are not simply a reflection of the technical complexity of the final app, but are based on peer feedback, students' reflection in the presentation, and evidence of the design process in the design notebook. Very rarely does a learner not achieve this advanced level of competency. Furthermore, because the final project typically involves the largest number of VR scenes and assets they've dealt with, learners start to push the boundaries of the technology, prioritizing VR performance optimizations to balance functionality and aesthetics. We are often surprised and impressed by their creative workarounds; further evidence that the students have become the masters.

How to implement Virtual Reality classroom

Classroom Setup for VR Learning

Creating an environment conducive to learning virtual reality is one of the first steps in ensuring student success. The classroom is organized with tables pushed against the walls to provide each student with a work area for their computer and design notebook while leaving the central area open for VR activities. Safety is our first priority; we mark "VR boxes" with tape on the floor as designated boundaries for students to work within while using the headsets. While in VR, students use their headsets to draw boundaries that match these designated areas so they will receive notifications if they step outside them. Outside of VR, these boundaries demarcate a safe working area to prevent collisions with tables, chairs, or other students, offering a secure environment for immersive learning. This setup has ensured the students felt safe and comfortable in VR, without the fear of bumping into things.

Spotter Training

Spotter training is our primary strategy for safely introducing students to VR usage. During their first few sessions in VR, students pair up, with one student casting their VR screen onto a laptop while the "spotter" monitors their laptop and physical surroundings. The spotter is tasked with their safety and the safety of those around them: they make sure the student in VR stays in their VR box, remove potential hazards, and strategically warn them whenever a foreign object gets near. For example, a successful spotter would tell their VR teammate to "stop, take a step backwards" to warn of an obstacle in front of them rather than "watch out for the chair" (the student in VR would not be able to see the chair and thus would not know what to do to avoid the hazard). After the designated time in VR elapses, the students switch roles. Spotters also support their partner's getting in and out of VR, serving as a check to ensure the headset is on correctly and the controllers are secure. This is especially helpful as VR does have the potential to make users feel unwell or trigger underlying conditions. For example, a successful spotter could remind their VR teammate to close their eyes first before removing the headset, to aid in the transition from virtual reality to reality.

Additionally, the spotter serves as a collaborator in learning VR. Through casting, they are able to follow along with what their partner is doing in VR. Together, pairs can work on assignments in real time and troubleshoot any difficulties along the way. Ultimately, spotter training is phased out in week 4 (subject to change) when students demonstrate safe conduct in practice scenarios and graduate to become independent VR users. Overall, having spotters not only bolsters technical and interpersonal skills but also fosters a supportive learning environment, promoting confidence and constructive relationships among learners.

Managing a fleet of headsets
Each learner is assigned their own Meta Quest 3 headset for their use in the classroom over the duration of the quarter. The VR headsets are set up in advance with a unique admin account to manage app purchases and facilitate shared access to these apps. The admin accounts are crucial; these accounts purchase the apps used in the class which are then able to be shared with up to three other (student) users on the dedicated headset. They also allow us to retain admin privileges to troubleshoot any problems with the technology. Students are asked to create their own password-secured Meta Horizon account for use on their assigned headset, enabling them to save progress, seamlessly switch devices if needed, and retain access to their work after the class ends. These Meta accounts also make features like casting possible. By integrating these account systems, we ensure a smooth user experience while promoting student ownership of their work.

Why the Meta Quest 3?
We selected the Meta Quest 3 for its strong performance, large base of compatible apps, and advanced safety features. The built-in boundary system alerts students when they approach the edge of their designated working area, while passthrough mode allows them to see their surroundings without removing the headset. These features are critical in maintaining a safe environment, enabling students to fully immerse themselves in their creative projects. That being said, the Meta administration for Business is not used as it is prohibitively expensive for academic use but would likely help streamline the initial set up and app maintenance.

ShapesXR
ShapesXR plays a central role in the class, enabling students to prototype VR environments and integrate custom Blender assets without relying on significant programming skills. Each ShapesXR assignment in our class is established as a ‘Project’ in shapes.app (ShapesXR’s website where we manage projects and collaborative spaces); students are manually added as editors to each class Project (Lab assignment) where they share their ‘Space’ - the ShapesXR artifact that they have been working on. This process serves as their assignment submission. ShapesXR also facilitates collaborative design in VR, allowing learners to work together in the same space while in virtual reality. For the art gallery project, we use shapes.app functionality to stitch together individual student projects into a shared VR art gallery, organizing their works in a cohesive space so that learners can move freely about in VR and view each art piece as if they were in a real gallery. ShapesXR even supports limited integration with Blender. After exporting their Blender creations as .obj or .glb files, students can upload them to ShapesXR's platform where they could be used as assets in their app environment. Another key feature is the ability to

edit VR environments from the browser. It is a normal occurrence to have learners who prefer to work on their apps and projects outside of VR, whether it is due to already spending too much time in virtual reality, feeling dizzy or tired, having an illness whose symptoms are exacerbated by VR, or simply that they do not have access to their headset directly.

Results

Introduction to Creative Design in Virtual Reality is successful in achieving its goals to teach advanced application design in Virtual Reality to early learners in a supportive and accessible way. Most learners remain engaged throughout the quarter with teams frequently completing final projects that push the boundaries of the technology and expectations of the teaching team. Learners in general feel very strongly about the course; comments made during class and the class Discord, as well as post-teaching quarter emails from the students, express their appreciation for the VR lab as a space where they "*can be themselves*." Students even show their interest by joining up with the teaching team to refine the content and teach the next iteration. These outcomes are confirmed through feedback from the learners, though they also make suggestions for improvement and growth with each iteration of the class.

While the above sentiments are based on anecdotal observations of the teaching team, quantitative and qualitative course results and feedback from each offering are captured through:

- Externally administered and anonymous quarterly exit surveys for learners, designed to surface their learning and confidence in engineering technical and professional skills; the efficacy of different instructional features; and sense of belonging and community (n = 33).
- Student Evaluations of Teaching (an anonymous end-of-course survey administered by the university for all classes).
- External evaluations with lightly-structured student and student-teacher interviews.

Analysis of quantitative survey data using descriptive statistics confirms that students have not only substantively improved their engineering and professional skills, but also their confidence in using these skills both inside and outside of a classroom setting (Data shown in Figure 7 in the Appendix). Much of this improvement reflects the effectiveness of classroom instruction, captured from the learners' perspective in these surveys. The majority of learners rated the surveyed instructional features as Helpful or Very Helpful (3 or 4 on 4-point Likert items, Figure 8 in the Appendix). Though learners still make suggestions to improve the class, including better integration of art and design-related topics into the projects and in-class activities. As expected, the "*Final Project*" rated highest among learners with 100% rating it Helpful/Very Helpful followed by "*Open Lab*" hours and "*Support from the teaching team*."

Inductive analysis of qualitative data helps to elucidate subtleties within the quantitative results. Emergent themes from across learner responses provide insight into the aspects of the class that were more impactful for student learning and engagement. Here we pair the general themes with an example of a coded student response:

- Learners described the classroom environment as "*enjoyable*" in a manner that supports "*community*" by having students come together and talk about ideas.
  "*I felt the [student] instructors helped me feel engaged with the course "very frequently" with their constant check–ins and by calling on students for questions in class. I also felt like the instructors wanted me to succeed and that they were doing their best to help me*"- Learner response in SETs.

- Student-instructors come to class "*prepared*" with "*clear teaching practices*" and are "*accessible*" - due to their age, they are easy to communicate with.
  "The [student] instructors helped me feel engaged with the course "very frequently" because they always came to lecture with fully prepared slides and activities. Meanwhile, all the instructors are my age, which is easy to communicate with." -Learner response in SETs.
- The scaffolded projects (in-class activities and labs) and generous (open) time in VR supported learner achievement levels in the final project.
  "I found the use of hands-on learning tools in VR to be very helpful, even things like playing games in VR helped increase my fluency in utilizing the various tools available to us in VR."
  -Learner response in SETs
- Learners were generally "*glad*" they took the course and utilized open responses to express their appreciation for the perceived opportunity.
  "It was a really cool opportunity, and I'm glad I could take it." -Learner response from internal survey

Fostering a Community in the Classroom

As student-instructors, it is important to us that the class feels like a supportive and inclusive community where students can freely share ideas, collaborate, and grow together. We want students to look forward to coming to class rather than being intimidated or unmotivated. Quantitative survey data on the classroom climate shows that we achieved this goal. The majority of students responded Yes (4) or Definitely Yes (5) to 5-point Likert questions targeting students' comfort and sense of belonging in the learning environment, capturing feelings of diversity, inclusivity, and student-instructor approachability. Notably, 100% of students responded in strong agreement with the prompt "*I can be myself during class time*."

From day one, we prioritize creating an environment where every student feels valued and encouraged to participate. We realize this by incorporating group activities, fostering open communication, and emphasizing the importance of peer support. Group projects, collaborative brainstorming sessions, and class discussions are all designed to strengthen connections among students and help them learn from one another. In our group assignments or activities, we make an effort to group students with others they haven't worked with before so that they have a chance to build new relationships and gain fresh perspectives. This way, students feel comfortable chatting and going to each other for help when they get stuck, a strategy facilitated by the frequent usage of the class Discord. When working on longer projects, we organize feedback sessions where students meet to discuss their ideas and help each other with their work. These sessions cultivate a kind and supportive environment that encourages diverse voices and constructive critique, where students see their classmates as pillars of support as opposed to competitors as seen in a typical college classroom setting.

"I enjoyed this class a lot more than I expected I would have. This was very different from any class I have ever taken and I have never done anything in VR before until this class. After taking this class and experiencing VR with wonderful professors and peers, I would gladly do it again!

-Learner response from internal survey

However, student-instructors are the key to achieving true community within the classroom. We are up to date with pop culture references and normally use (and understand) the language that students use, whether it be new slang or other words that have shifted their meaning over time, creating a more casual and accessible learning environment. This connection is why we relate better to what students consider fun and can use this understanding to shape the curriculum both in and out of the classroom. With this sense of familiarity, we appear less intimidating than professors, and learners feel more comfortable asking questions and participating in discussions. Students regularly approach us asking questions about the creative limits of the assignment and whether they could incorporate elements of pop culture–a personal touch that increases investment in their work. Additionally, our ability to tune into the social and emotional climate of the class allows us to adapt our teaching to be a more supportive learning experience.

"Thanks for being so kind :) I am very insecure but you and the teaching team helped me find my groove love y'all." -Learner response from internal survey.

The approachability of student-teachers is key in supporting learners in getting help when they need it. We bridge communication by utilizing a popular communication channel, Discord, that students already use and is deemed "informal" in a typical classroom setting. Students constantly send messages in the group chat at all hours, especially nearing an assignment deadline. Not only are we more likely to respond quickly, as students ourselves, we are available to respond outside of business hours–especially late at night, when we notice most learners doing their work–which is beneficial to them. This general accessibility also means that learners have an avenue to discuss general student life with students who are a year or two ahead. Student-teacher office hours are more casual and open to the learners to 'drop into' the VR lab, where they get help, work with teammates, or challenge us to a round of BeatSaber (VR game). Many students feel so comfortable that current or even past students stop by just to hang out between classes, which is something very rarely seen in more traditional academic settings.

"I think the discord was especially helpful, as you'd get answers to questions within minutes and that's usually nice." -Learner response from internal survey.

Conclusions & Moving Forward

Since the initial Winter '24 class, the course evolved over its subsequent four offerings from getting to know VR headsets with emphasis on scene setup in ShapesXR toward its more formal incorporation of the User Experience and advanced Blender tools for asset creation. These improvements reflect an iterative instructional design approach that incorporates continuous student feedback and new ideas from the regular onboarding of new student-instructors – some of which were themselves once learners in this class. While the continual iteration and refinement of the class successfully addresses feedback, limitations, and challenges emergent with each course offering, these adaptations often reveal new challenges that come from pushing the boundaries of teaching emerging technology in a classroom setting. Namely, as students become more advanced, they may struggle more with the tools, discovering the limits of Blender/ShapesXR integration. Recognizing these hurdles, we reserve a week of course content for unplanned 'bonus' material to leave space to support learners where they are at and act on their feedback during the active quarter. In this way, we systematically integrate learner feedback during and between quarters to become responsive and supportive in addressing learner needs while maintaining academic rigor, improving both student engagement and overall outcomes. The success of this course carries implications for broader educational practice by demonstrating that undergraduate student-instructors can effectively bridge communication gaps with their peers, creating learning environments that feel accessible and engaging. The core principles of our course such as scaffolded learning, peer collaboration, and creative exploration provide a foundation for teaching not just VR design but potentially any emerging technology.

Appendix

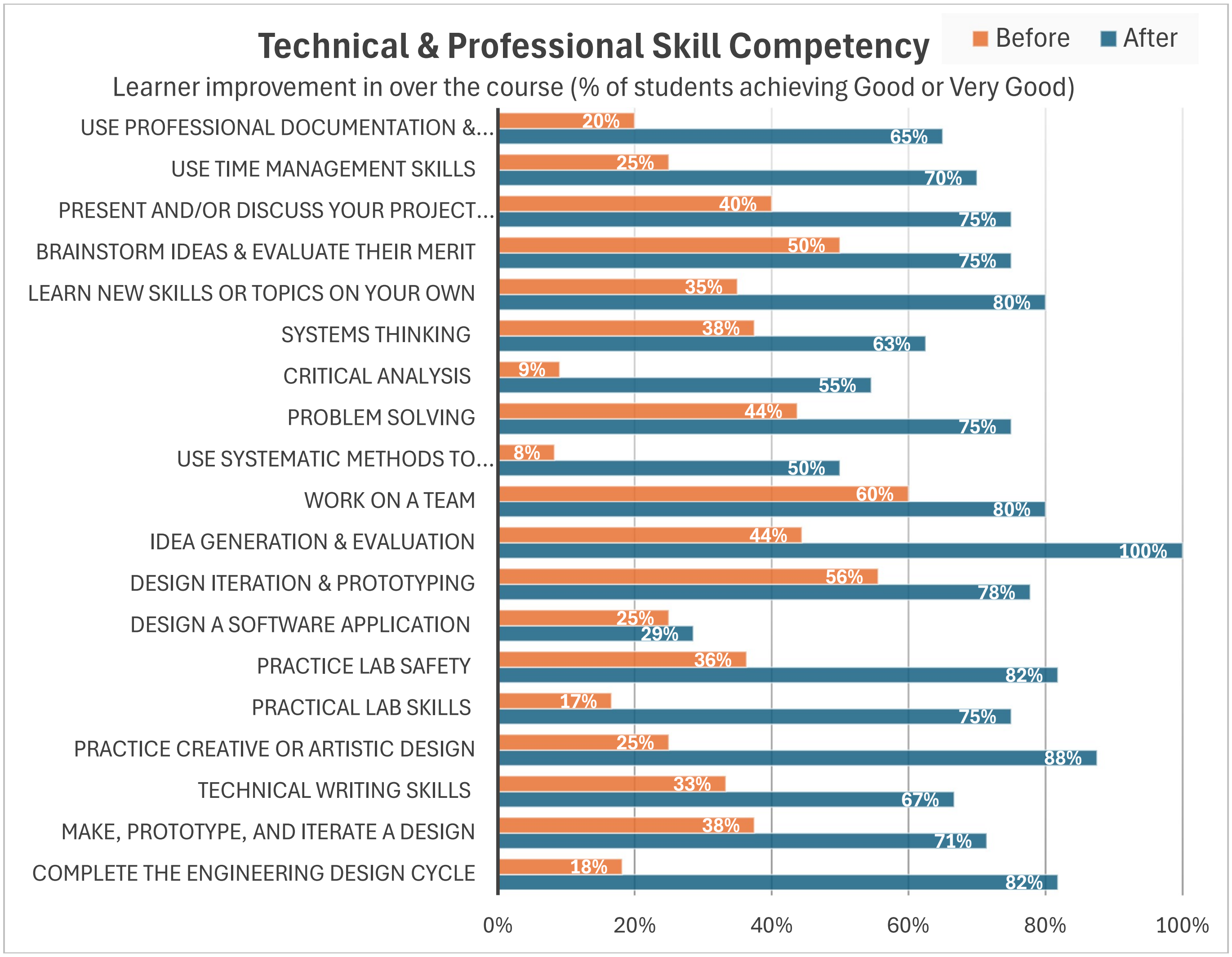


Figure 7: Student responses to 5-point Likert items assessing their own skill level in both technical and professional engineering outcomes. The values show the percentage of students rating themselves as "Good" or "Very Good" in the specific skills at the end of the course (blue) compared to their perceived skill proficiency at the beginning of the course (orange). This presentation is a subset of the skills assessed; we included those that most closely align with the class's learning outcomes. Note that this framework of the data is an indirect measure of learner confidence but does not capture all improvement. For example, for the learning outcome "Design a Software Application,"50% of learners initially stated they had No/Poor skills in this area, while 43% rated themselves as Good by the end of the quarter.

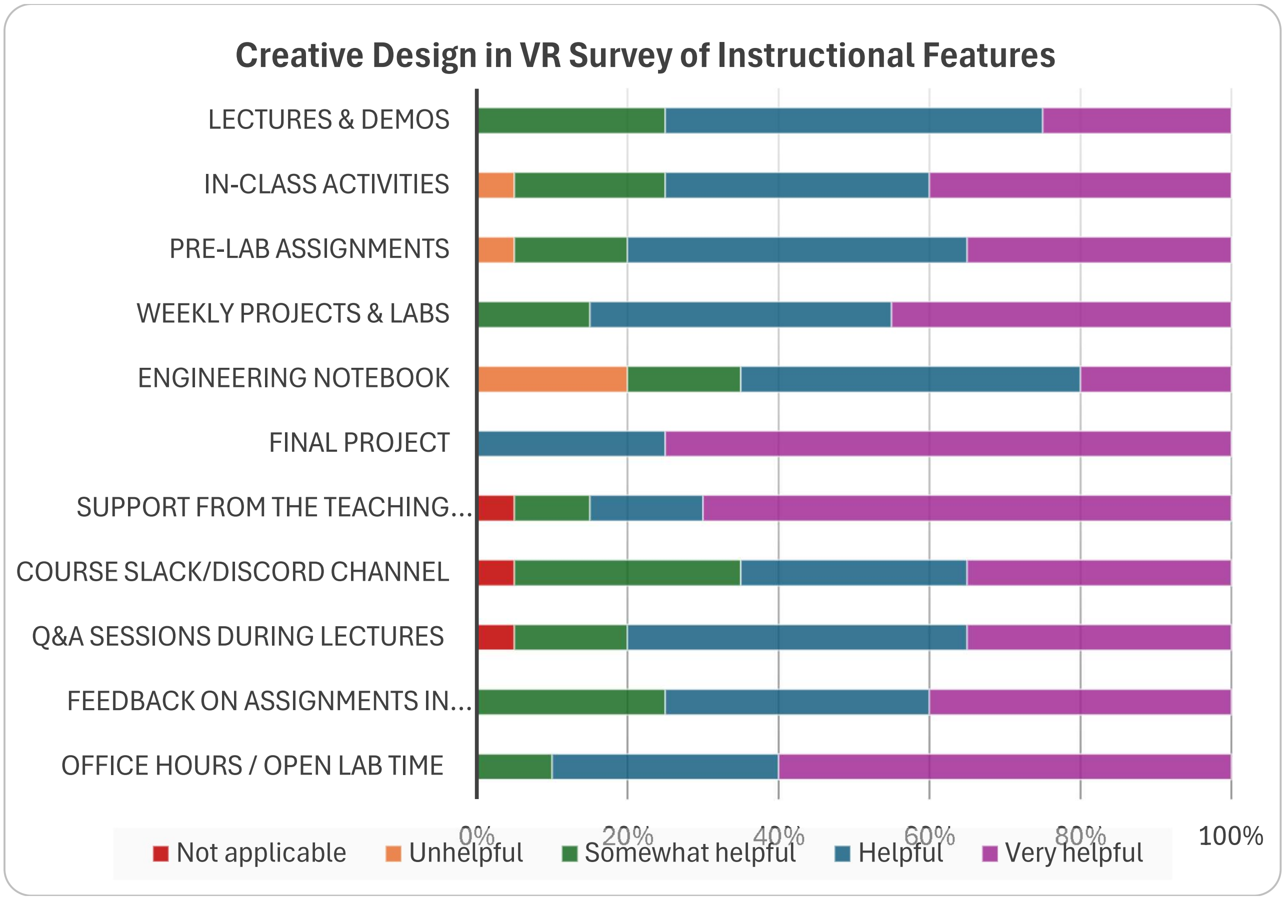


Figure 8: Student responses to 4-point Likert survey prompts evaluating the helpfulness of the course learning artifacts and structure. Orange = "Unhelpful," Green = "Somewhat Helpful," Blue = "Helpful," and Purple = "Very Helpful." Red indicates that a student did not perceive that learning artifact as a part of the course. The data shows that most students found the majority of the instructional features helpful for their learning.

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