# Asymmetrical VR for Education

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**Figure 1: Students in VR class are fully immersed in VR while the instructor monitors and guides them through tablet and desktop computer.**

## ABSTRACT

In collocated VR classes, instructors need to guide their students, while also remaining aware of the physical environment in order to ensure students' safety. It is hard to do both simultaneously.

We present a system that utilizes hand-held devices for non-VR instructors, enabling them to explore VR content and interact with students who are fully immersed in VR. The instructor can observe the VR environment or switch between different students' first-person views by using commonly available hand-held devices, such as smartphones and tablets. The instructor can also use hand-held devices to interact with the VR world itself.

The students can see the real-time video stream of the physical environment as well as a video stream of the instructor. The system enables seamless communication and collaboration, thereby helping to create a better and richer educational experience for VR classes.

## KEYWORDS

Asymmetric, view casting, VR, education

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## 1 INTRODUCTION

In recent years, Virtual Reality (VR) has gradually been adapted into the classroom. It can provide an immersive and engaging learning experience for students, but it also presents some unique challenges. Generally, it is not ideal for instructors to stay in VR all the time during the VR class. Due to the immersive nature of VR experiences, it is not easy for non-VR instructors to understand what is going on in the VR environments without taking on and off the students' headsets all the time. If the instructors' vision and hearing are occupied by VR, it would be hard for them to get access to additional teaching materials, or have rich interactions with the students as they would do in physical communications. It could break or lower the class experience if instructors couldn't understand the problem responsively, therefore no responsive guidance or support, when a student is experiencing discomfort or difficulty in VR. Health and safety concerns caused by running into potential physical hazards are also inevitable for students who are fully immersed in VR.

To address these challenges, instructors need to guide the students in VR while staying in the physical environment with an asymmetric paradigm. Asymmetric collaborations, especially hand-held devices including smartphones and tablets, can help improve the collaboration and communication between VR and non-VR participants by providing a shared space. Asymmetric VR platforms can help connect the non-VR instructor and the VR students[Thoravi Kumaravel et al. 2020; Wang et al. 2022]. With asymmetric VR, the instructors don't have to wear a VR headset all the time in a VR class while they can easily take a quick look at the students' VR content with their hand-held device. Instructors can use tools like observer modes or screen sharing to see what the user is experiencing in real-time. In the meantime, they can provide clear instructions and guidance on how to navigate the VR environment

safely and effectively, and monitor the students' progress to ensure that they are engaging with the content correctly.

Our system allows instructor to use hand-held devices such as smartphones and tablets as a display and controller to monitor and manipulate the VR environment for better teaching experience. They can see the VR classroom as an observer, or jump into any student's view in VR in order to help that student with such tasks as finding objects, constructing things or using interactive controls. The instructor can also use their hand-held devices to take the students on a journey to different VR worlds. To enhance the communication between the instructor and the students, our system can also live stream the video captured by the hand-held device to allows the students to look at the instructor or the physical materials for the class.

In summary, our goal was to enable students to explore VR under the guidance of a instructor, and to provide that instructor with tools that help to create the best educational experience for students using VR in the classroom.

## 2 SYSTEM DESIGN

Our system integrates VR headsets, a hand-held device such as iPad or phone, and a desktop computer to construct an asymmetrical VR classroom. The hand-held device requires a camera and a touch screen for the full features. Each VR headset will have its unique QR code attached to its front for position tracking.

The system utilizes two tracking approaches for hand-held devices to align their positions and orientations with the corresponding VR environment: 1. with marker-based tracking, the hand-held device uses its camera to identify the physical QR code attached to the student's headset. The position and orientation of the hand-held device are determined by the relative transform between the QR code and the hand-held device. 2. With markerless tracking, the hand-held device uses its camera and sensors to detect its position and orientation relative to the environment; in this method, the hand-held device has to align its pawn position in VR with the physical world.

### 2.1 Asymmetric views

This system enables instructors to view the VR contents from two different perspectives: one is from the student's VR view (Cast Mode), and the other is from a third-person perspective (Observer Mode). The VR view is streamed to the instructor's hand-held device in real-time, allowing them to monitor the students' progress and provide immediate feedback.

*2.1.1 Cast Mode.* The hand-held device can display the target student's VR view by selecting the target from the student list. The instructor can make the selection by pointing the top end of the hand-held device to the target student.

*2.1.2 Observer Modes.* The third-person perspective view provides a comprehensive view of the VR environment. It can help instructors to see beyond the students' view by moving their hand-held devices to pick an arbitrary perspective in the VR environment[Wang et al. 2021], which allows instructors to understand better what the students are viewing and facilitates the assessment process.

### 2.2 Interaction

We provide instructors with hand-held devices such as smartphones and tablets as interfaces to guide and interact with the students and the VR environment for educational purposes.

*2.2.1 3D Content Manipulation.* The instructors can use the hand-held devices' positional and orientational tracking as controller to manipulate the 3D objects transformation. When they are doing so, they can switch to the desktop computer's screen to inspect the changes made in VR. They can also use the touch screen to create sketches, selecting objects, and changing the VR classroom by swapping the environmental models.

*2.2.2 Video Streaming.* The system will live stream the video feed captured by the hand-hold device to the VR system when the instructor chooses to do so. It allows the students in VR to have face-to-face communication with the instructor, and make it possible for the instructor to show the students physical teaching materials.

## 3 USER EXPERIENCE

In our asymmetrical VR classroom, students will be wearing VR headsets, immersed in a virtual classroom and explore the world with the guidance of the instructor.

The instructor will pick up the tablet to look into that virtual classroom. They can navigate the classroom as an observer to see what the students are generally doing, or aiming their tablet's camera to a particular student to see their first person view for detailed instructions. The instructor can provide instructions by sketching on the tablet, such as circling out the object they wish the students all to look at or writing down a formula, and it will be reflected in the students VR world. They can also use the iPad as a controller to manipulate the 3D objects or change the VR environment for the class, and monitor the scene using the desktop computer.

The video feed collected by the tablet's camera will be live streamed into the VR world when the instructor wishes to have face-to-face communication with the students or show them something in the physical world.

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