

Visual Indicators for Monitoring Students in a VR class

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ABSTRACT

Remote classes using VR technology are gaining recognition when in-person meetings are difficult or risky. We designed an immersive VR interface with several visual cues to support teacher awareness of students and their actions, attention, and temperament in a social VR environment. This interface keeps relevant information about students within the teacher's visual field of attention and has options to reduce the amount of information presented. Pilot study participants preferred to see all student indicators in one place and suggested we minimize the amount of information displayed to focus on the most urgent students.

Index Terms: Human-centered computing—Virtual reality

1 INTRODUCTION

Networked VR has recently been deployed for remote presentations to broaden access or overcome risks of in-person meetings during the spread of the SARS-CoV-2 virus. For example, Mozilla Hubs was used for the IEEE VR 2020 conference and Virbela was used for ISMAR 2020. Others [4] considered that networked social VR tools might be valuable for remote classrooms by supporting co-presence or other aspects lacking in video-only tools. However, current VR tools do not provide the same cues about audience actions and attention as in-person meetings, for example, subtle face and body motion cues are missing. Furthermore, the field of view and visual detail are reduced. We developed an interface for a VR-immersed teacher to better understand students and respond to problems or actions. One goal is to clarify student actions and locations and to let the teacher better identify problems. The interface can summarize head or eye gaze [3] and attention levels or temperament as determined by motion or physiological sensors (this work focuses on visual cues and not on the mechanisms to detect such states).

2 INTERFACE DESIGN

Our environment resembles social VR environments like Mozilla Hubs, with full-size avatars representing students. We add a visual interface to compactly present key information about the class in the teacher's field of attention (an area that is easily visible at any angle in the HMD). Three main components work in tandem: a scoring component to classify student behavior, an indicator placement component that mitigates clutter, and a display component.

2.1 Scoring and Student Actions

Simultaneously showing information for many students is problematic due to clutter. Our solution includes an importance score that determines whether or not a student has a problem or is performing an action (raising a hand, speaking into a microphone, or typing). This per-student score indicates whether or not the teacher needs to be especially aware of (and see an indicator for) that student. One factor of the score is attention level, which we currently estimate

from eye gaze, using the relevance and timing of multiple gazed-at objects [2]. Other factors are actions and temperaments (for example, based on facial expressions or physiological data).

2.2 Indicator Placement

An indicator is a visual element in the teacher's view that summarizes student status. To mitigate overlapping of indicators at the same view angle, a group of nearby indicators can be combined or collapsed to reduce space required to display information. We had the following indicator placement options:

Class-wide: A single class-wide collapsed group limited within the field of attention of the teacher (see Figure 1). To visually represent student statuses with an indicator, a variety of visual elements are employed (see Figure 2).

Floating: Default indicator position is above a student's head to make the relationship between the indicator and the student clear (see Figure 1). If this position is outside the field of attention, the indicator will be displayed at the closest point inside the field of attention (students may be anywhere they choose, including behind or above the teacher). We use shortest-arc rotations of indicator positions around the viewer to bring indicators to the field boundary.



Figure 1: Indicator placement: Class-wide (left), Floating (right)

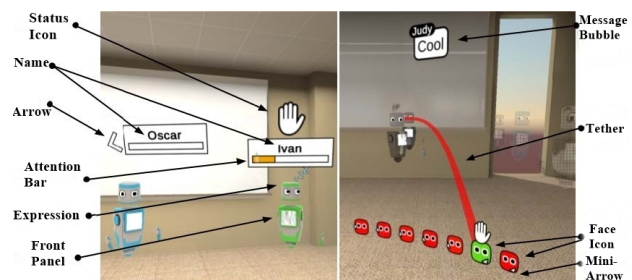


Figure 2: Indicator elements: floating (left), Class-wide (right)

2.3 Display

There are three options for multi-student indicators (Figure 3):

- 1. Face Icons:** Icons colored according to importance (green to red) and with eye motion based on eye tracking (teacher-relative). Above each icon is a status icon depicting any current student action.
- 2. Single Bar:** A bar emphasizing only the most critical students in a group indicator, reducing the summary complexity.
- 3. Segmented Bar:** A bar containing multiple importance scores as segments, with critical scores on the left and good scores on the right, allowing the teacher to further overview the distribution of importance scores.

Additional options for Face Icons: Face icons can be sorted based on student position or importance (Figure 4). They can be arranged

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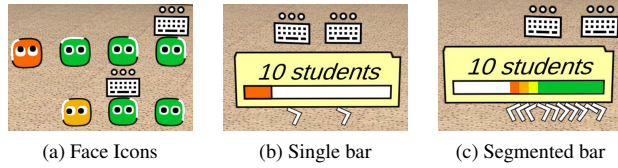


Figure 3: Collapsed indicator types

in a single row (see Figure 4) or multiple rows (see Figure 1). The student eye gaze motion can be toggled on and off. To direct the teacher towards the student position, there are 3 styles of on-icon directional cues (Figure 5): *Edge Highlights* color a portion of the icon edge to indicate direction. *Blips* are small arrows on the icon edges, pointing towards the student. *Arrows* are larger and appear underneath icons. A fourth positional indicator is *tethers*: 3D cubic curves connecting indicator elements to student avatars (Figure 6).

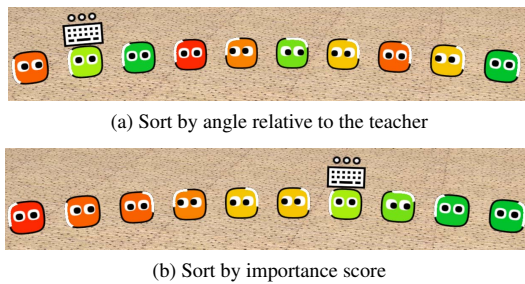


Figure 4: Indicator sorting options

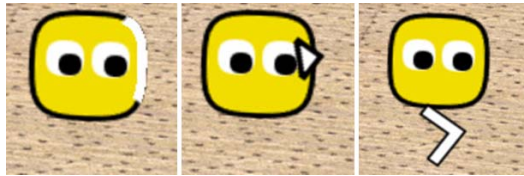


Figure 5: Student position indicators: Edge highlight, Blip, Arrow

Responsively-triggered elements: Some elements expose additional information when the teacher “hovers” over them with eye gaze or ray pointing. For example: the front panel on the avatar’s chest (Figure 2) flips out and displays a history graph of recent attentiveness, color coded by temperament.

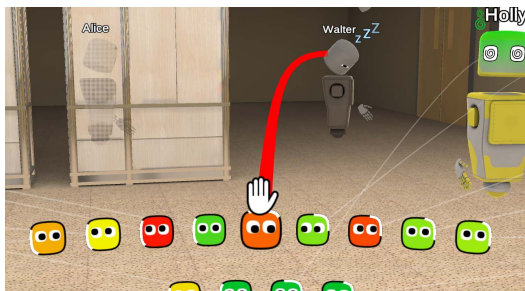


Figure 6: Tethers between face icons and students. The most urgent tether is red and prominent, and others are subtle.

3 PRELIMINARY STUDY RESULTS

In a pilot study, 11 subjects (8 males and 3 females, aged 23 to 38) provided insight into the visual techniques. Subjects in a virtual

lecture room with 20 simulated students selected preferred settings for the visual cues and explained the reasons behind their preferences. Some of the preferences are summarized in Table 1.

Table 1: Summary of preferences. The number next to each option indicates the number of participants who preferred that option.

Q1	Indicator placement		
	Classwide : 10	Floating : 1	
Q2	Collapsed indicator display style		
	Face Icon : 7	A Single Bar: 1	Segments: 3
Q3	Avatar names enabled		
	Yes: 10	No: 1	
Q4	Minimal student direction display style		
	Edge Highlights: 3	Blips: 8	
Q5	Overall student direction display style		
	Highlights/Blips: 5	Arrows: 6	
Q6	Moving eyes enabled for face icons		
	Yes: 8	No: 3	
Q7	Number of rows for face icons		
	In one row: 3	Multiple (two) rows: 8	
Q8	Indicators appear		
	For all students: 2	For important students: 9	
Q9	Tethers appear		
	When urgent: 8	Always: 2	Never: 1
Q10	Indicator sorting criteria		
	By importance: 5	By student angle: 6	
Q11	Sorting order		
	Descending: 5	Ascending: 6	
Q12	Hover trigger method		
	Eye tracking: 3	Controller: 8	

4 CONCLUSION AND FUTURE WORK

We proposed an interface to help a teacher monitor students in a VR classroom. Our pilot study participants preferred to see all student indicators in one place and suggested we minimize the total amount of information displayed to focus on the most urgent students. In future studies, it would be interesting to see how the adjusted interface performs with teachers actually teaching lessons and simultaneously keeping track of the students. More details about the implementation and results are found in [1].

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