

Investigating the Impact of a Virtual Reality Experience on Medical Student Empathy: A Mixed-Methods Study

Allen G Mundok, Vivian N Ho, Lauren A Fowler, Ann B Kennedy, Shannon Stark-Taylor

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Allen G Mundok^{1*} BS; Vivian N Ho^{1*} BS; Lauren A Fowler^{2*} PhD; Ann B Kennedy^{1*} DrPH; Shannon Stark-Taylor^{1*} PhD

¹ University of South Carolina School of Medicine Greenville Greenville US

² Wake Forest University School of Medicine Charlotte Charlotte US

*these authors contributed equally

Corresponding Author:

Ann B Kennedy DrPH

University of South Carolina School of Medicine Greenville
607 Grove Rd
Greenville
US

Abstract

Background: Physician empathy is important not only for improving patient satisfaction and health outcomes but also for increasing physician job satisfaction and protecting against burnout. Amidst concerns over declining empathy levels in medical education, however, there is a need for innovative teaching approaches that address the empathy gap, a critical element in patient-centered care.

Objective: This study used a mixed-methods analysis to explore the effectiveness of a Virtual Reality (VR) intervention versus traditional lecture methods in enhancing empathy among medical students.

Methods: Fifty first- and second-year medical students were randomized to either a VR intervention, which simulated patient experiences, or a control group receiving traditional empathy lectures. Both groups watch two videos with reflections gathered after each video to capture students' experiential learning. Empathy was measured using the Jefferson Scale of Empathy (student version) before and after the intervention.

Results: Quantitative analysis revealed significant increases in empathy scores post-intervention for both groups (control group: mean increase = 4.71, SD = 11.01; VR group: mean increase = 5.6, SD = 10.02; $p < .001$), indicating that both interventions enhanced empathy. The VR group exhibited a significant difference in qualitative empathy coding after the second video ($U = 165.5$, $p < .001$) compared to the control. Qualitative feedback from the VR group emphasized a more profound emotional and cognitive engagement with the patient perspective than the lecture group.

Conclusions: This study supports the integration of VR into medical education as a complementary approach to traditional teaching methods for empathy training. VR immersion provides a valuable platform for students to develop a deeper, more nuanced understanding of empathy. These findings advocate for further exploration into VR's long-term impact on empathy in clinical practice.

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Original Manuscript

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Allen G. Mundok, Vivian N. Ho, Lauren A. Fowler, PhD, Ann B. Kennedy, DrPH, Shannon Stark Taylor, PhD

Bios

A.G. Mundok is medical student researcher, University of South Carolina School of Medicine Greenville, Greenville, SC. V.N. Ho is medical student researcher, University of South Carolina School of Medicine Greenville, Greenville, SC. L.A. Fowler is professor, Wake Forest University School of Medicine Charlotte, Charlotte, NC. A.B. Kennedy is associate professor and director, Patient Engagement Studio, University of South Carolina School of Medicine Greenville, Greenville, SC. S.S. Taylor is clinical associate professor, Department of Family Medicine, University of South Carolina School of Medicine Greenville, Greenville, SC.

Corresponding author contact (Dr. Kennedy)

Correspondence should be addressed to Dr. Ann Blair Kennedy, University of South Carolina School of Medicine Greenville, 701 Grove Road, Greenville, SC, 29607; telephone: 864-766-2028; email: kenneda5@greenvillemed.sc.edu; Twitter: @abklmt

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Key Words: medical education; virtual reality; medical students; mixed-methods; empathy

Introduction

Empathy can be interpreted as the emotional engagement of the observer with the circumstances of another ¹. When a physician is empathetic, it leads to increased patient satisfaction and patient health outcomes including adherence with treatment, expedited recovery from surgery, and decreased use of pain medication ². For example, individuals with diabetes who have physicians with higher empathy are more likely to have better glucose and cholesterol control than those with lower empathy scores, controlling for a number of other physician and patient factors ³. For physicians, increased empathy results in higher supervisor ratings of clinical competence, decreased malpractice litigation, and increased job satisfaction ⁴. Furthermore, empathy may be protective against burnout ^{5,6}; thereby, training to increase empathy may help reduce burnout in the healthcare workforce. Additionally, despite the known benefits of empathy, research has shown that as medical students advance in their careers as physicians, their empathy decreases over time ⁷.

Studies have demonstrated the effectiveness of many different modes of empathy training for increasing in empathy ratings in medical students ^{8,9}. To train individuals in empathy, traditional interventions have often taken the form of perspective-taking. These interventions involve having participants imagine another's situation and put themselves "in that person's shoes". Perspective-taking has also been shown to promote empathy in a range of non-medical contexts ¹⁰⁻¹².

Compared to traditional perspective-taking, VR interventions offer a fully immersive experience, giving the user the visual and emotional feeling of being present for the interaction and embodying another ^{13,14}. One study compared traditional perspective-taking to a VR perspective-taking intervention using a virtual environment to promote increased empathy for homeless persons. Participants who underwent the VR intervention showed more positive, longer-lasting attitudes toward the homeless and signed a petition supporting the homeless at a significantly higher rate than those who engaged in a traditional perspective-taking task ¹³. Studies suggest VR interventions are less cognitively taxing than imaging another's perspective and allows for improved methodology as all participants engage in the same exercise ¹⁵⁻¹⁷. As medical students are using technology resources to enhance their classroom learning ^{18,19}, finding ways to integrate technology resources into empathy training may be an effective method to engage medical students ^{20,21}.

Although VR technology has been used to promote empathy for several different human conditions in lay people, few researchers have applied this technique to physicians or medical students. To help facilitate perspective-taking among medical students, we designed an innovative virtual reality experience and compared it to traditional teaching methods. We hypothesize that engaging in patient perspective-taking through VR will result in greater increases in empathy as compared to traditional teaching methods (a video lecture).

Methods

Participants

From January to February of 2020, 50 first- and second-year medical students at the University of South Carolina School of Medicine Greenville (USCSOMG) participated in our study. Students were recruited by flyers posted throughout the medical school building and ads placed in emails and other electronic communications. Participation was voluntary, and students were incentivized with a \$30 gift card compensation. IRB approval was granted, and informed consent was given by all participants. Individual responses and identifying information were kept confidential.

Study Design and Video Development

To compare the efficacy of a virtual reality experience to traditional lecture learning, we used a randomized controlled mixed-methods convergent parallel design. In this study design, both qualitative and quantitative data were gathered in one phase of the research, analyzed separately, and then merged to find where the results converged ²². Merging the qualitative and quantitative data strengthens study outcomes by providing more comprehensive results ²².

The lecture videos were PowerPoint lectures designed and narrated by a biomedical sciences professor and research team member (L.A.F.) with expertise in empathy. Control Video 1 described the science behind empathy and its importance in healthcare. Control Video 2 provided strategies for students to enhance empathy in clinical practice.

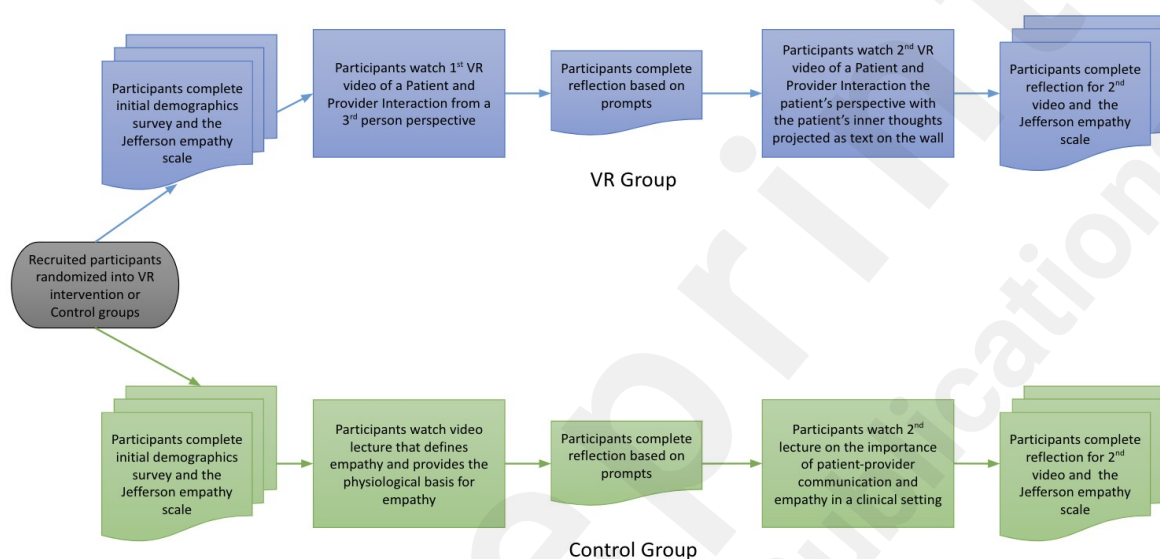
To make the VR videos and reflection questions as authentic as possible, these items were presented to a panel of patients and providers trained in giving feedback to researchers. The panel members made suggestions for script and question improvements. After incorporating the received feedback into the revised script, the VR videos were filmed using a Garmin VIRB Ultra 360 camera (Garmin, Ltd., Olathe, KS) with hired actors playing the roles of a patient and physician. VR Video 1 presented a third-person perspective of a "normal" patient-physician interaction during a routine office visit. VR Video 2 showed the same interaction but through the first-person perspective of the patient, and the patient's inner thoughts were projected as text on the screen for students to read. An example of the patient's thoughts is "How am I going to afford a dietitian? Will my insurance pay for that?" Videos for the control and intervention group were designed to be the same length to control for time.

Data Collection

Using a random number generator, students were randomly assigned to either a control group (n=25) or intervention group (n=25) (Fig. 1). In the control group, students were given a tablet to watch the two PowerPoint lecture videos on empathy. In the intervention group, students wore a VR headset to watch the two VR videos depicting a patient-physician interaction. Prior to watching their respective videos, students completed an initial demographics survey and the Jefferson Scale of Empathy for medical students (JSE S-version). After watching the first video, students answered three open-ended reflection questions on their learning experience. Students then watched the second video and again completed the three reflection prompts and the JSE. Figure 1 depicts this methodology.

Throughout their viewing of the videos, students in both groups were also equipped with Empatica E4 wristbands (Empatica, Inc., Cambridge, MA) to measure physiological markers of empathy such as galvanic skin response and heart rate variability. However, due to artifacts, this data was corrupted and could not be interpreted; it was therefore not included in our final results.

Fig. 1 Flow of data collection



Instruments

The validity of the JSE in evaluating empathy in physicians and medical students has been well-established²³. We used the student version (S-version), which was developed to measure medical students' attitudes toward empathy in patient-physician interactions. The JSE contains 20 items, each answered on a seven-point Likert-type scale (1 = strongly disagree, 7 = strongly agree). An example of a typical item is "Patients feel better when their health care providers understand their feelings." A higher score implies higher empathy, with a maximum total score of 140.

We developed our own reflection questions as open-ended prompts that assessed students on their learning experience after viewing the videos. The control questions asked students to describe the video, to describe how the video made them feel, and to explain how they would apply the information in future practice. The intervention questions asked students to describe the video, to describe how the video made them feel, and to explain how they thought the patient felt during the interaction.

Analysis

We conducted qualitative analysis based on the participants' responses to the reflection prompts. We imported the responses into Microsoft Excel (Microsoft Corporation, Redmond, WA) and used a modified thematic content analysis approach of open coding. Initial codes were created by reading the text provided by the participants and assigning a code identifier. Coding was an iterative process in which each instance of a code was compared to previous instances to confirm or modify the code and its definition. Once all the data was coded, emergent themes were abstracted by grouping similar codes together. Codes and themes were each reviewed by members of the research team (A.M., V.H., A.B.K., S.S.T.). Any discrepancies were resolved through discussion until consensus was reached. Major themes and illustrative quotes from the participants' responses will be presented in the discussion.

We then determined quantitative scores based on the level of empathy present in the participants' responses. We assigned empathy scores to each participant based on their responses to video 1 (R1) and responses to video 2 (R2), and we also

assigned an overall empathy score based on their responses to both videos 1 and 2 (R3). Empathy was scored on a three-point scale (1 = no signs of empathy, 2 = some signs of empathy, 3 = high signs of empathy). We used our codes to assign these empathy scores. High signs of empathy were indicated by codes such as “patient focused” and “emotive words,” while low signs of empathy were indicated by codes like “surface level” and “misperception.” We also used a three-point scale to assign each participant a score for level of change in assigned empathy scores from video 1 to video 2 (1 = negative change, 2 = no change, 3 = positive change).

The data were quantitatively analyzed by L.A.F. using IBM SPSS Statistics Version 29.0 (IBM Corp., Armonk, NY). Descriptive statistics (counts and frequencies for categorical data; means and standard deviations for continuous data) were performed. We used Mann-Whitney tests to compare the assigned empathy scores at R1, R2, and R3 between the control and intervention groups. JSE scores pre- and post-test were analyzed using paired-samples t-tests to determine whether JSE scores changed over time for all participants. A factorial analysis of variance assessed whether time (pre/post-test) and group (control/intervention) affected JSE scores. To confirm a relationship between the JSE and our assigned empathy scores, we ran a Spearman correlation between post-test JSE score and R3 for both control and intervention groups. We considered *P* values less than .05 as statistically significant.

Results

Of the 50 pre-clinical medical students that participated in our study, the overall mean age was 24.14 (2.66). The majority of participants were female ($n=37$, 74%) and white ($n=31$, 62%). There were similar numbers of participants in each class year, with 24 M1 students (48%) and 26 M2 students (52%). Eight participants (16%) identified as first-generation students, and 14 participants (28%) were from rural backgrounds. Specialty of interest varied among the participants, but the highest number of students ($n=11$, 22%) chose obstetrics and gynecology. Additional demographic information is depicted in Table 1.

Qualitative analysis of participants' reflection responses in the control group versus the intervention group revealed 4 major themes relating to empathy and its learning that diametrically opposed each other: 1) markers of empathy, 2) student engagement, 3) learning empathy, and 4) deeper meaning found (see Figure 2). The control group responses overall demonstrated lack of empathy, lack of engagement, lack of learning, and lack of deeper meaning. While control group students seemed to cognitively acknowledge the importance of empathy, their responses were generally sarcastic and demonstrated low levels of empathy. For example, when asked how the lecture video made them feel one student responded simply with, “bored.” Another stated, “this video made me feel sleepy... this is all stuff we have heard before.” When asked how they would apply the lecture content to future clinical practice, one student responded with “be empathetic like I was supposed to be before?” By contrast, the intervention group responses showed empathy, engagement, higher learning, and deeper meaning. Intervention group students experienced a range of empathetic emotions after the VR experience, with one student stating that they felt “frustrated, upset, overlooked, angry, defeated, and many other negative feelings” on behalf of the patient. The intervention group participants were highly engaged, commenting “I felt like stepping in and asking the patient for input,” and “I felt like I wanted to be Sam's advocate and ask questions... the provider should've asked.” Because the VR videos promoted perspective taking, the students found deeper meaning. One individual stated: “I think the patient... needed to talk about his feelings just as much, if not more than his abdominal pain.” The intervention group also demonstrated learned empathy in their responses. After watching the first video, one participant commented, “I felt that the physician was doing a good job being pleasant.” After the second video, the same participant stated, “I felt like I had been transported into the patient's shoes; I felt worried when he felt worried, and I became frustrated when the doctor didn't give him any feasible solutions because I identified with him at that point.”

A Mann Whitney analysis was used to compare the assigned empathy scores at R1 (after video 1) and R2 (after video 2) between the control and VR groups. Results indicate that there was no significant difference in qualitative coding for empathy scores between the two groups after the first video (R1). However, after the second video (R2), there was a significant difference between qualitative scores, with those in the VR group having significantly higher empathy coding scores than the control video, $U = 165.5$, $p < .001$. A Mann Whitney analysis also showed that overall qualitative empathy coding for the participants (R3) was significantly higher for those in the intervention/VR group as compared to those in the control group, $U = 202.5$, $p < .05$. The overall qualitative coding for empathy (R3) was assessed with the post-JSE scores to determine if the two scores were related to each other (a quantitative rating of empathy compared to the coding of the qualitative rating). Spearman correlation between post-test JSE and R3 for both the control and intervention groups were significantly, positively correlated, $\rho(49) = .294$, $p < .05$. Refer to Figures 3a and 3b for more information.

JSE scores were assessed prior to and following each testing session (pre/post-test) for both the control and intervention groups. Pre-JSE scores for the control group averaged 113.73 (SE = 10.57), while the pre-JSE scores for the intervention

group averaged 113.39 (SD = 10.24). Post-video averages of the JSE scores showed the control group averaged 118.44 (SD = 11.01), and the intervention group averaged 118.99 (SD = 10.02). A paired-samples t-test was used to determine whether JSE scores changed across time for all participants. Results indicate that JSE scores significantly increased after the empathy training sessions compared to before the sessions, $t(49) = 7.28$, $p < .001$. A factorial analysis of variance assessed whether time (pre/post) and group (control/experimental) affected JSE scores, with results indicating no significant effect of either, $F(1, 48) = .169$, $p > .05$. Refer to Figure 4 for comparison of JSE scores across time for both groups.

Table 1. Demographics of study participants $n(\%)$ unless otherwise noted

Variable	Control N = 25	Intervention N = 25	Total N = 50
Age mean (sd)	23.92 (1.53)	24.36 (3.46)	24.14 (2.66)
Sex			
Male	8 (32%)	4 (16%)	12 (24%)
Female	16 (64%)	21 (84%)	37 (74%)
Transgender	1 (4%)	0 (0%)	1 (2%)
Race/ethnicity*			
Asian	2 (8%)	7 (28%)	9 (18%)
Black/ African American	4 (16%)	5 (20%)	9 (18%)
Hispanic/Latino	1 (4%)	0 (0%)	1 (2%)
White	18 (72%)	13 (52%)	31 (62%)
Another/Not listed	2 (7.7%)	0 (0%)	2 (4%)
Decline to answer	0 (0%)	1 (4%)	1 (2%)
Class Year			
M1	13 (52%)	11 (44%)	24 (48%)
M2	13 (48%)	14 (56%)	26 (52%)
Marital Status			
Single, never married	23 (92%)	21 (84%)	44 (88%)
Married	2 (8%)	4 (16%)	6 (12%)
First Generation	4 (16%)	4 (16%)	8 (16%)
Rural	7 (28%)	7 (28%)	14 (28%)
Specialty			
Dermatology	0 (0%)	2 (8%)	2 (4%)
Emergency Medicine	2 (8%)	1 (4%)	3 (6%)
Family Medicine	1 (4%)	2 (8%)	3 (6%)
General Surgery	6 (24%)	2 (8%)	8 (16%)
Internal Medicine	2 (8%)	1 (4%)	3 (6%)
Internal Medicine-Pediatrics	1 (4%)	0 (0%)	1 (2%)
Interventional Radiology	1 (4%)	0 (0%)	1 (2%)
Obstetrics & Gynecology	5 (20%)	6 (24%)	11 (22%)
Ophthalmology	1 (4%)	0 (0%)	1 (2%)
Orthopedic Surgery	2 (8%)	2 (8%)	4 (8%)
Otolaryngology	1 (4%)	1 (4%)	2 (4%)
Pediatrics	1 (4%)	5 (20%)	6 (12%)
Undecided	2 (8%)	3 (12%)	5 (10%)

*responses options allowed respondents to check more than one option

Fig. 2 Major Themes and Representative Quotations

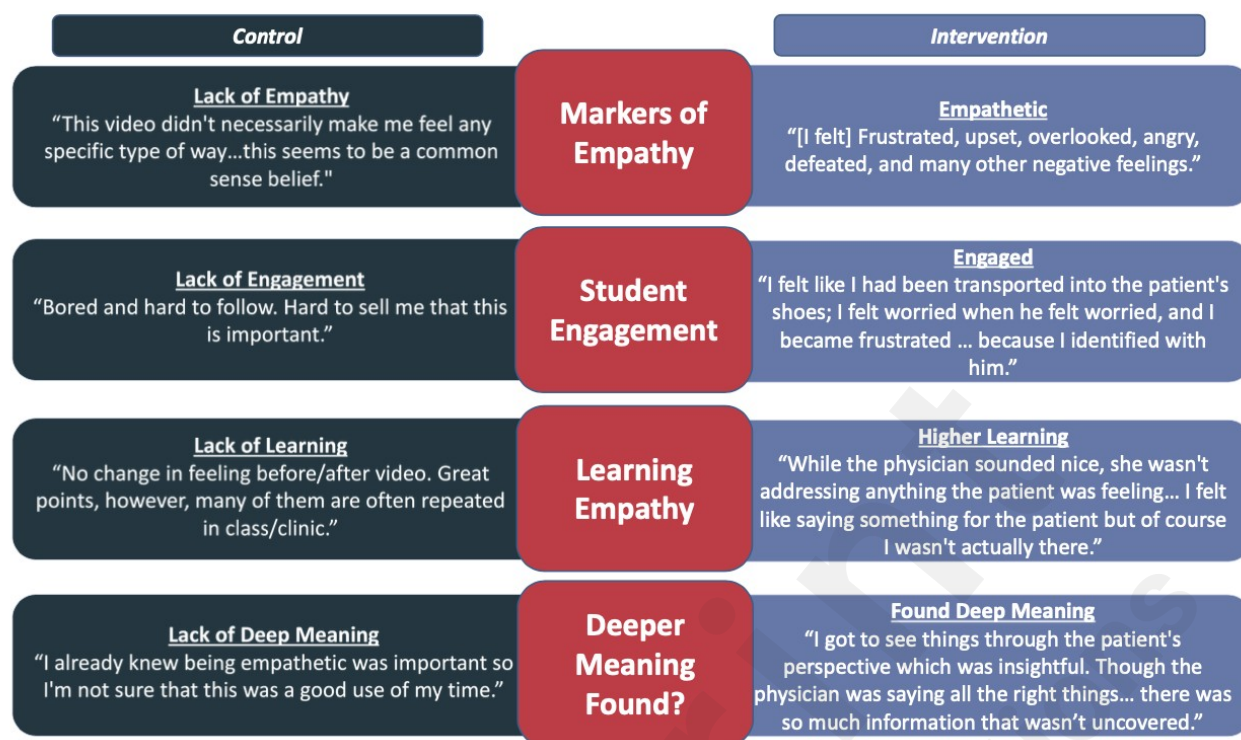
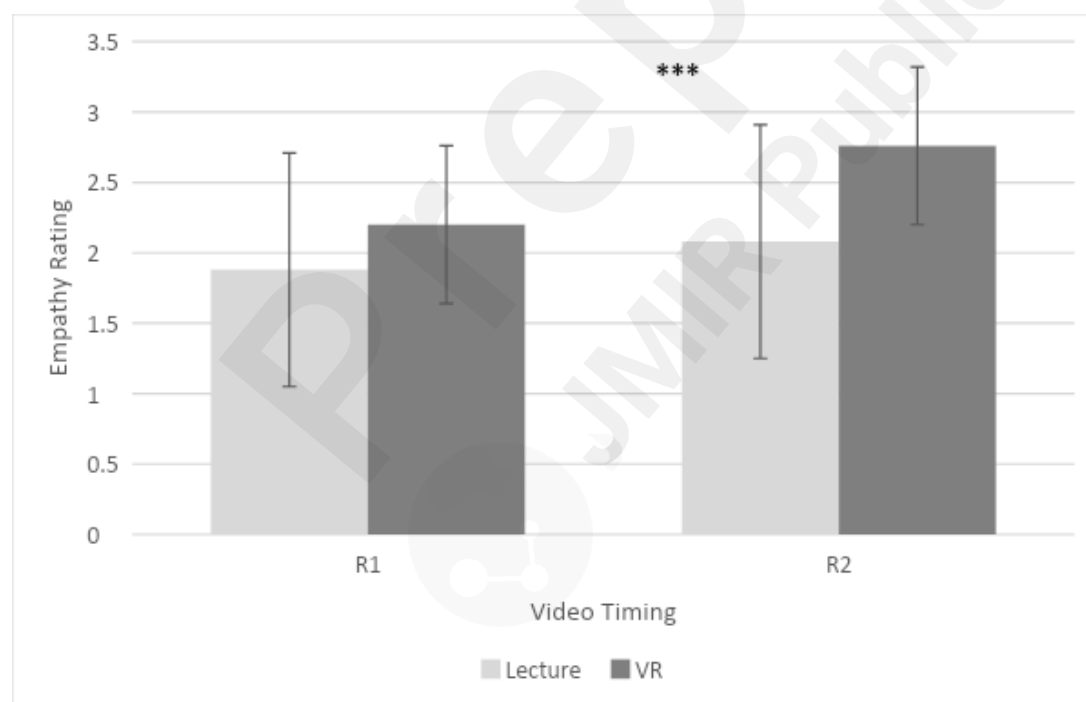


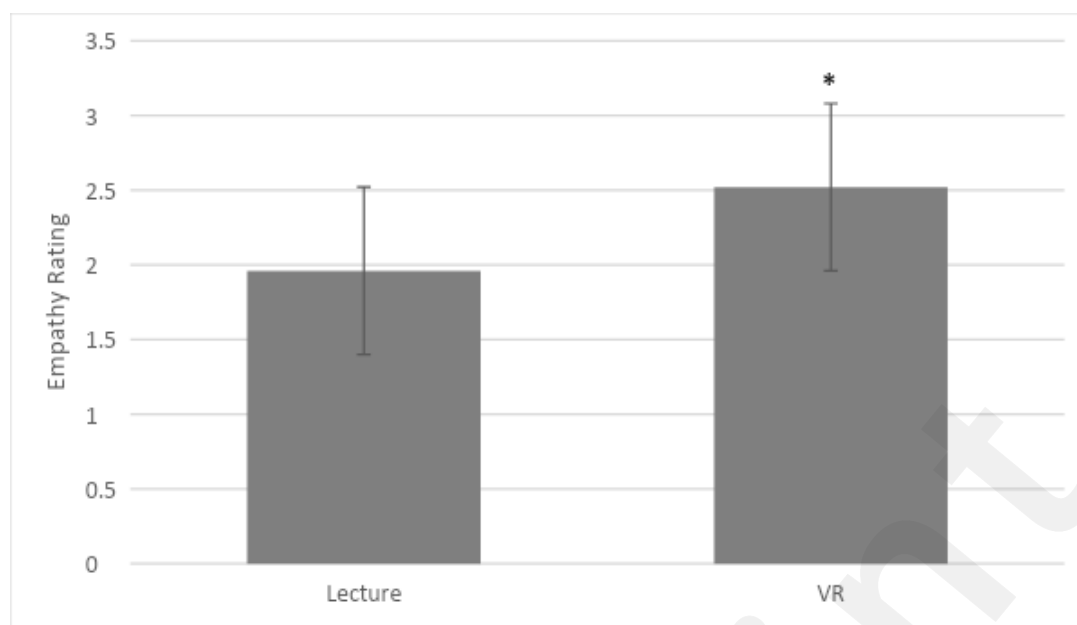
Fig. 3 Qualitative Scoring of Comments

Fig. 3a Qualitative Scoring of Comments After Video 1 (R1) and Video 2 (R2).



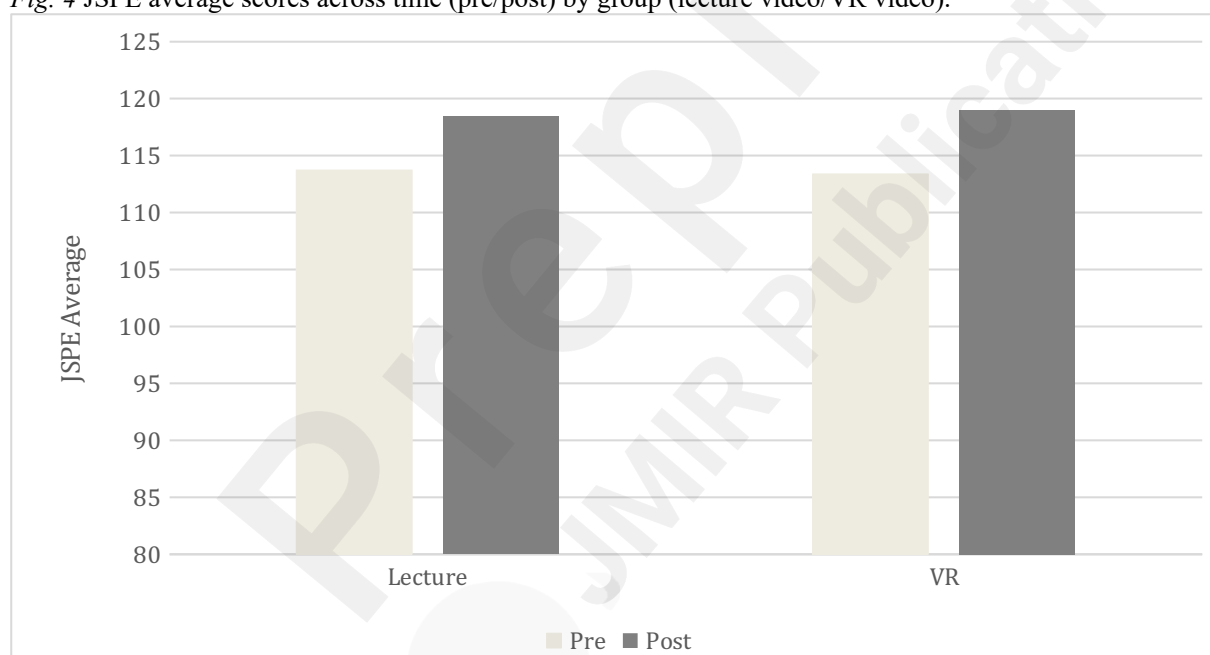
Standard deviation error bars are shown. *** $p < .001$

Fig. 3b Combined qualitative scoring of all comments after Videos 1 and 2 (R3).



Standard deviation error bars are shown. * $p < .05$

Fig. 4 JSPE average scores across time (pre/post) by group (lecture video/VR video).



Standard deviation error bars are shown. *** $p < .001$

Discussion

This study presents early findings that the virtual reality experience uniquely engaged students and elicited more empathetic responses compared to the traditional lecture. In our mixed-methods evaluation, the intervention/VR group demonstrated qualitatively higher markers of empathy, more student engagement, found deeper meaning, and demonstrated more learning of empathy than the control group. The intervention/VR group also showed significantly higher overall assigned empathy scores than the control group.

The Jefferson Scale of Empathy is widely used and has been validated by numerous empirical studies as an instrument to measure empathy²³. Our quantitative analysis conducted using this tool demonstrated a significant increase in JSE scores after both empathy training sessions compared to before the sessions. Seeing an increase in JSE scores in both groups post-test is not a surprising result considering students were primed on the topic of physician empathy while completing the questionnaire and since traditional teaching methods have already been proven effective in teaching empathy to some

degree^{8,24,25}. However, the VR intervention's efficacy in fostering empathy underscores the importance of experiential learning, as outlined in adult learning theory, and provides a new dimension to empathy theory in medical education. Adult learning theory emphasizes the significance of self-directed, experiential learning processes, where adults learn best when engaged in activities that relate closely to real-life scenarios or challenges they might face²⁶. The immersive nature of VR, by providing medical students with a first-person perspective of patient experiences, leverages these principles effectively, offering a profound, emotive learning experience that traditional didactic methods may lack. This approach aligns with the constructs of empathy theory, which posits that empathy involves not just cognitive understanding but also affective sharing and emotional resonance with others²⁷.

Qualitative analysis helped us better understand the experiential differences between the groups. Themes from the qualitative responses relate clearly to the literature on empathy and adult learning. Individuals in the VR group described experiencing a variety of emotions while watching the VR video, while the control group described their experience using more cognitive language. This suggests that the VR intervention met our intent to promote perspective taking. Furthermore, adult learning theorists emphasize the role emotions can play in helping learners connect a construct with prior knowledge and past experiences²⁸. Beyond enriching their learning through perspective taking, the intervention appeared to uniquely engage students more than the lecture. The theme of deeper meaning found in the intervention group's reflections aligns with the concept of "presence" in virtual reality environments, the true feeling of "being there" in the virtual space. This sense of presence is critical for generating impactful, empathetic responses, as it bridges the gap between knowing about another's experience and feeling with them. Literature on VR and empathy underscores the role of presence in enhancing the emotional impact of VR experiences, suggesting that it is this immersion that enables learners to connect with content on a deeper emotional level, fostering a genuine understanding and appreciation for the patient's perspective²⁹.

For this topic in particular, embodied and applied experience seems to provide much more nuance to the concept of empathy versus the cognitive acknowledgement that empathy is important in practice. Through the comments, the intervention appeared to help many students more fully understand how empathy can promote better healthcare. Furthermore, this study's findings resonate with previous research indicating the potential of VR to overcome some of the limitations associated with traditional empathy training methods. For instance, studies have demonstrated VR's effectiveness in reducing cognitive load and allowing for a more standardized and immersive learning experience, characteristics that are particularly advantageous in the context of medical training where the cognitive demand is high and the need for consistent, reproducible training experiences is paramount³⁰.

Limitations and Future Directions

Our review consisted of a single-institution study at one academic center, meaning more work is needed to make more widespread application of our results possible. Furthermore, we did not follow up with participants after the end of the study to assess empathy during clinical rotations and in practice. We feel this would have provided a better understanding of how our intervention impacted the long-term impact of the empathy training throughout their medical training. We also recognize some limitations in our use of the Jefferson Scale of Empathy including the fact that we may have applied the scale too early following our intervention, thus potentially limiting its reliability. Compared to other interventions to promote empathy in healthcare learners, this intervention was quite brief; a systematic review of such interventions found that the average length was 10 hours³¹.

While traditional teaching methods have been shown to help increase empathy in medical students, the profound differences noted in our qualitative data, however, lead us to question whether full immersion through a VR experience may be a helpful additional tool in allowing students to develop a deeper understanding. Future directions warrant us testing a combined approach of traditional lecture alongside a VR intervention to see if a combination provides an even greater increase in empathy than either one alone. We would also like to assess the long-term impact of these interventions on students as they progress through their clinical years.

Conclusions

In conclusion, our study underscores the transformative potential of virtual reality (VR) interventions in enhancing empathy among medical students, suggesting a synergistic complement to traditional didactic methods. By immersing learners in the patient's perspective, VR offers a unique experiential learning opportunity that deeply engages both the affective and cognitive domains essential for empathetic development in medical practice. These findings illuminate the importance of adopting innovative, technology-enhanced educational strategies to cultivate a more empathetic healthcare workforce. As the landscape of medical education evolves, integrating VR as a tool for empathy training promises not only to enrich students' learning experiences but also to foster the development of more compassionate and understanding physicians. Our work lays a foundational step towards reimagining empathy training in medical education, advocating for a more holistic approach that prepares students to meet the emotional and interpersonal challenges of modern

healthcare with empathy and understanding.

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Conflicts of Interest

None to disclose.

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