embodied labs

The Effects of a VR Intervention

on Career Interest, Empathy, Communication Skills and Learning with 2nd Year Medical Students

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OVERVIEW AND BACKGROUND

Healthcare training today, whether in higher education, certification training, or professional continuing education, primarily consists of lectures backed up by power point presentations. Whether attended by the learner in person, watched as videos online synchronously or asynchronously, or simply downloaded and absorbed on the learner's own time, it still remains a fact that lecture and power point are both examples of passive learning activities.

One of the most commonly cited visuals for illustrating knowledge and information retention in passive vs. active learning is Edgar Dale's "Cone of Learning" (Figure 1A).

The cone of learning breaks learning activities into two types: passive and active. According to the cone, a power point presentation only presents learners with the maximum capability of retaining 30% of the material, or perhaps 50% if it is accompanied by some video clips and/or a live demo. This is a problem with any type of learning, but particularly with healthcare. Doctors, nurses, and other care providers and caregivers are faced with decisions that affect not only a patient's day-to-day health, but potentially their life and death. This high level of responsibility calls for high quality training with the best chance for retention possible.

MOVING TOWARDS ACTIVE LEARNING

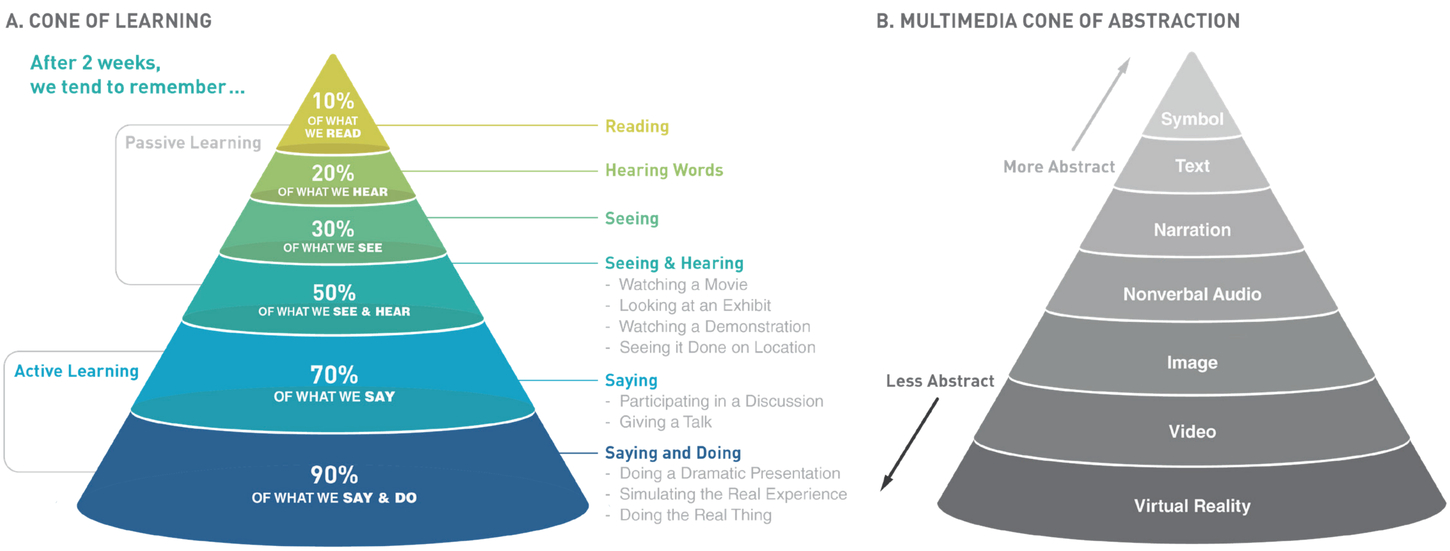
Many medical, nursing, and allied health programs across the country and world are heading in the direction of more active learning techniques, known by a variety of names such as "problem-based learning" (PBL), "case study-based learning," competency-based learning, flipped classroom, and more. In terms of Dale's Cone, the active learning techniques that health-care training programs are seeking to implement would fit most closely with the cone's "participating in a discussion" tier, with a 70% retention rate. That is better than 30% certainly, but wouldn't the opportunity to participate in an immersive, virtual simulation still be better? Simulation presents the learner with the optimum chance of retention, because it is the highest level of active learning possible, and is as close as you can get to actually doing something in real life. In 2013, Charles Baukal proposed an update to Edgar Dale's Cone of Learning that includes virtual reality, as seen below (Figure 1B).

VIRTUAL REALITY (VR) AND THE AGING CRISIS

In addition to a need for more effective training methods, the United States is currently in an elder care crisis. Over the next 20 years, the population of United States citizens age 65 and over is expected to nearly double from 12% to 20% of the total population (Institute of Medicine, 2008). As the aging demographic increases, so will the opportunities for careers that serve this population. However, studies show that there is a shortage of undergraduate and graduate students choosing to pursue age-related careers (e.g., geriatric medicine, geriatric nursing, physical, occupational, and speech therapy, social work, mental health counseling, etc.) (Eshbaugh, 2013). In the medical profession specifically, it is estimated that by 2025 there will be a shortage of 12,500 to 31,100 primary care physicians. Reasons for this trend have been identified as being due to lack of exposure to the aging population, negative stereotypes towards the elderly, and/or unfamiliarity with the aging experience (Heise, 2012). Fortunately, this problem can be addressed, at least in part, through educational interventions.

Virtual reality presents a unique opportunity to revolutionize healthcare education and training. VR utilizes technology to integrate with and test the efficacy of Dale's Cone of Learning with the theories of embodied learning and embodied cognition. Embodied cognition is a branch of cognitive science that emphasizes the essentialness of the body to the mind in any activity, including learning (Yee, 2006). Embodied learning is an emerging field based on embodied cognition concepts that merges the field of education and the learning sciences with computer sciences—more specifically human-computer interac-

FIGURE 1. (A) Cone of Learning after Dale, 1969 and (B) Multimedia Cone of Abstraction after Baukal, 2013.



tion. It follows then, that learning methods, activities, and systems that are part of embodied learning will necessarily involve a high degree of technology. Embodied learning could occur with both augmented and virtual reality, but it is VR that truly transports the learner into an alternate world, and can put them into the real world in which they will work and apply their skills once their training is complete.

EMBODIED LABS

Embodied Labs is an educational technology company that creates immersive embodied patient experience labs for healthcare trainees and professionals. Our hypothesis is that health care providers and caregivers will provide better care after embodying their patient, leading to greater patient satisfaction and outcomes. The Alfred Lab was created by an interdisciplinary team, with content experts from the University of Illinois Chicago, University of Illinois Urbana Champaign, Wake Forest School of Medicine and North Carolina School of the Arts, with representative input from students and experts in the fields of Biomedical Visualization, Medical Education, Computer Science, Learning Sciences, Communication, Biomedical and Health Informatics Systems, Curriculum and Instruction, Geriatrics, Cinematic Arts, Information Science, and Educational Technology.

THE EMBODIED LABS FRAMEWORK

FIGURE 2. Embodied Labs Framework

The Alfred Lab experience is based on Embodied Labs' Embodied Labs Framework (Figures 2 and 4), which has three stages:

1. Prepare
2. Embody
3. Reflect

The framework is not conceptually novel in that there are various pedagogical learning frameworks that involve the learner doing work beforehand, completing a learning experience (whether a traditional class lecture, a semester-long internship/clerkship, semester-long project, hands-on learning activity, etc.) and then reflecting on that learning experience. The novelty lies in the connections between the core "Embody" learning stage, and the "Prepare" and "Reflect" stages. Because The Alfred Lab has a VR simulation at its core, particular pedagogical considerations must be considered when moving the learning from the virtual world to the real world. These considerations are taken into account in the Embodied Labs Framework.

FIGURE 3. Students engaged in The Alfred Lab.

PREPARE:

Learners prepare to embody Alfred by taking a pre-assessment based on the learning outcomes for both the simulation and targeted to the competencies for their particular field (e.g. AAMC Geriatric competencies for med students), reading Alfred's case overview, and reviewing key terms & concepts.

EMBODY:

The core VR simulation or the The Alfred Lab was based on the curriculum for the geriatrics workshop part of the Essentials of Clinical Medicine course taken by second year medical students at the University of Illinois Chicago. The script was created by film directing students at the North Carolina School of the Arts with input incorporated from expert geriatricians. The Alfred Lab produced by this team of individuals blends a variety of individual skillsets to create a unique product with innovative educational implications. The learner experiences what it is like to have high frequency hearing loss and macular degeneration by putting on a VR head mounted display with Leap Motion hand tracking technology. The learner's hands are projected into the virtual environment, allowing them to self-associate their own movements as Alfred's (Figure 3). The 7-minute experience consists of six live-action 360° video scenes, across which Alfred faces his family's concerns about his health, experiences a daydream, visits a geriatrician, takes a cognitive test, and receives a diagnosis. Interactive CG objects include a field of pickable flowers, a pencil and paper cognitive test, and putting on a hearing aid.

REFLECT:

Learners reflect upon new knowledge by engaging in discussion with peers outside of the headset by utilizing the questions in the facilitation guide, and taking a post-assessment.

METHODS

In October of 2016, we began a pilot study to test the efficacy of The Alfred Lab with a class of approximately 200 2nd year medical students at the University of Illinois-Chicago. Embodied Labs pilot study was designed to test three theories:

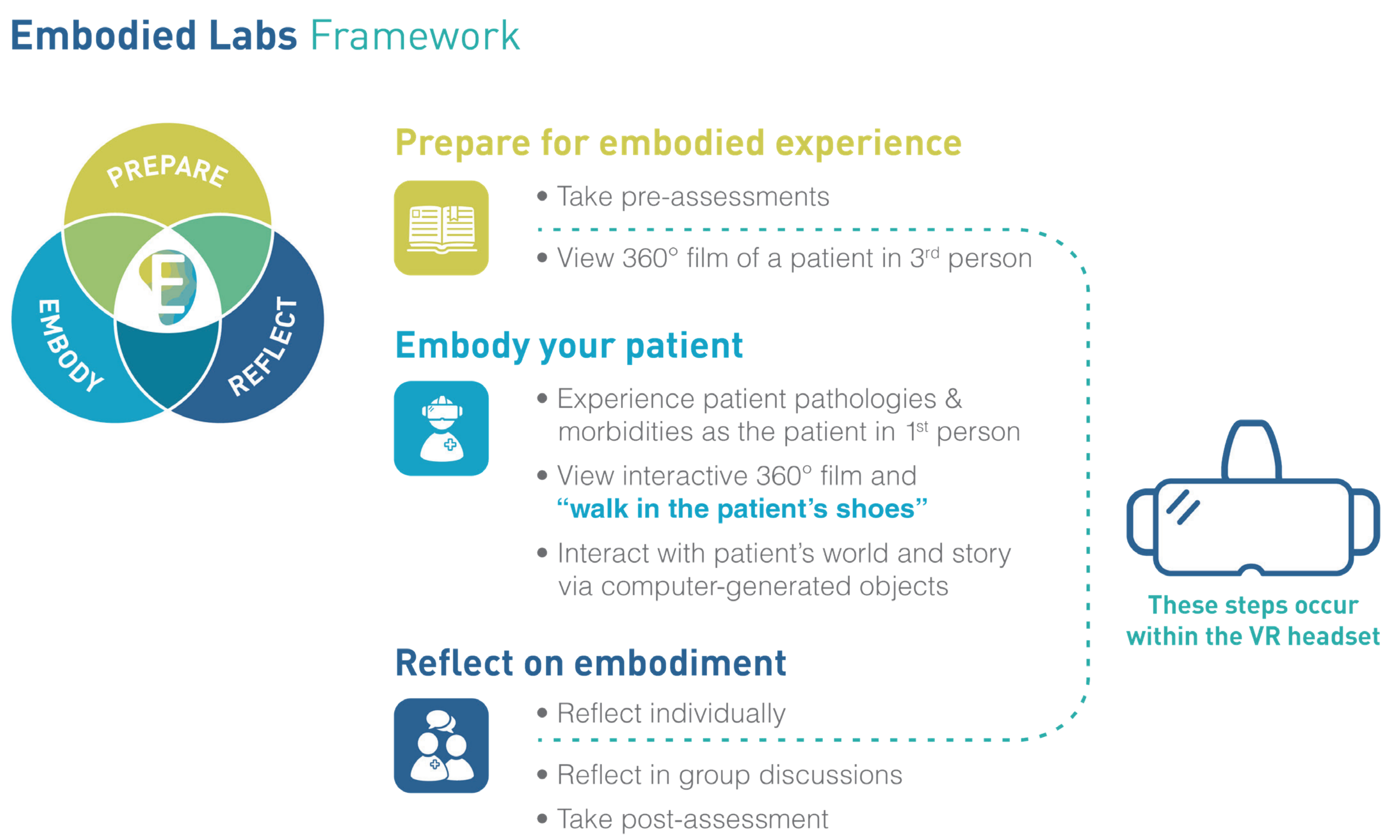
1. Embodying an older adult patient will lead to greater empathy for older adults.
2. Embodying an older adult patient will lead to more thorough knowledge of morbidities, etiologies and pathologies that affect older adults.
3. Embodying an older adult patient will lead to more interest in the geriatrics specialty overall.

The standard format for learning about geriatrics internal medicine is a part of the second year medical students' Essentials of Clinical Medicine course, where students participate in an hour-long plenary lecture by an expert in the field, and then break into a three-hour workshop led by a 4th year medical student and a group of their peers.

The Alfred Lab pilot study consisted of two stages:

1. Forty students came to the lab at UIC on two different days before attending their geriatrics lecture. Embodied Labs team members were there with the VR hardware and Embodied Labs software. All forty students embodied Alfred through The Alfred Lab software, first taking a pre-assessment, then embodying Alfred in the VR headset, followed by a post-assessment with identical questions to the pre-assessment aside from the demographics. Students were assigned a number to track data between the pre- and post-assessments, while still keeping their answers anonymous. Two weeks later, they attended their geriatrics lecture and break-out session. UIC conducted a focus group (with no Embodied Labs members present) to obtain feedback from the students.
2. In January, two months after the geriatrics lecture, 52 additional students came to the lab and embodied Alfred via The Alfred Lab, again taking a pre- and post-assessment before and after.

FIGURE 4. Detail of Embodied Labs Framework.



This gave us two sets of comparable data with the pre-assessment October group as Control Group 1 and the post-assessment October group as VR Intervention Group 1, with The Alfred Lab as the VR intervention. The pre-assessment January group is Control Group 2 with the post-assessment January group as VR Intervention Group 2.

1. Control Group 1 (n=40) in October shows student knowledge and ideation BEFORE any exposure to the geriatrics material in the course, as compared to VR Intervention Group 1 (n=40) which shows student knowledge and ideation after ONLY the simulation and no other course material.
2. The Control Group 2 shows student knowledge and ideation AFTER the geriatrics lecture, but BEFORE they experienced The Alfred Lab simulation (n=52) as compared to VR Intervention Group 2 which shows student knowledge and ideation after BOTH the lecture and the simulation (n=50).

RESULTS

Demographics

As part of the pre-assessment, we gathered basic student demographics (Figure 5). Taking the average of the October and January groups (n=92), 55% of students were male; 45% were female. All students except for one were 2nd year medical students. (The 4th year student was one of the breakout session leaders and was curious to try what the 2nd years were trying.) UIC-Chicago is one of the most racially diverse universities in the entire country, and their medical students reflected this. 38% of students identified as White/Caucasian; 31% as Asian, 15% as Latino; 13% as Black/African-American, 2% as Middle Eastern and 1% as other or prefer not to answer. Finally, 79% of students were between the ages of 23 and 30; 12% between 18 and 22; and 2 percent between 30 and 45.

Quantitative Multiple-Choice Questions

Student interest in pursuing a geriatric specialty (Figure 6)

One of the questions on the assessment asked students about their interest in pursuing a specialty in geriatrics. In Control Group 1, over 79% of students indicated that they were either strongly disinterested or somewhat disinterested in pursuing a career in geriatrics medicine. After the VR intervention, the "strongly disinterested" group fell by 16% and the "somewhat interested" group gained by 12%. Though these percentages seem slightly significant, the paired t-test showed "no statistical significance" (Table 1).

In Control Group 2, 77% of students indicated that they were "disinterested" in a geriactrics career. The VR Intervention Group 2 reported a 3% drop in "strongly disinterested" and a further 4% drop in "somewhat disinterested". That 7% went to the "somewhat interested" group, for a total of 70% being "strongly disinterested" or somewhat disinterested in a geriatrics career, and 30% being

FIGURE 5. Demographics (average of the two control groups)

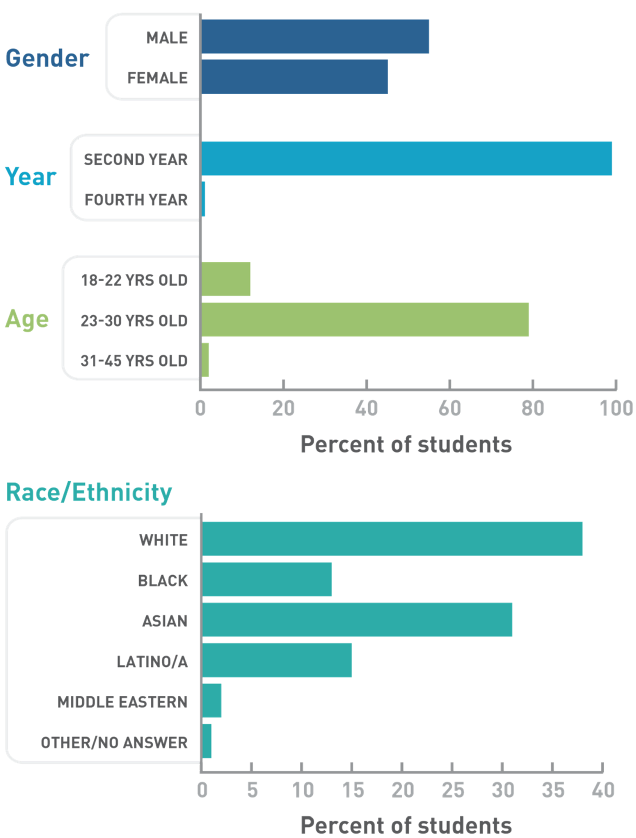


FIGURE 6. Interest in geriatrics as a career

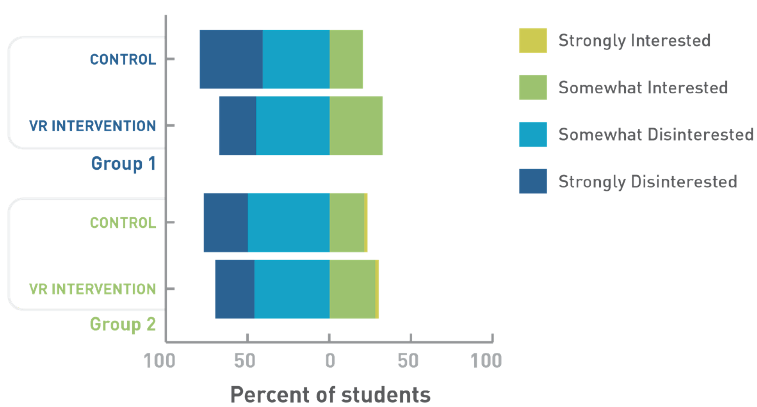


TABLE 1. Interest in geriatrics as a career (t-test)

	Control 1	VR 1	Control 2	VR 2
Mean	0.88	1.13	1	1.1
SD	0.72	0.72	0.74	0.79
Sem	0.11	0.11	0.1	0.11
n	40	40	52	50

KEY: 0 = STRONGLY DISINTERESTED, 1 = SOMEWHAT DISINTERESTED, 2 = SOMEWHAT INTERESTED, 3 = STRONGLY INTERESTED "somewhat interested" or "strongly interested". However, the t-test again showed no statistical significance.

Even with the results of the t-test not showing a statistical difference, the assessments do show that education about the older adult population does lead to slightly more interest in pursuing a geriatrics specialty. This can be seen in more students choosing "somewhat disinterested" rather than "strongly disinterested", and a 12% increase in students who chose "somewhat interested" after the simulation in VR Intervention Group 1, and a 6% increase in the VR Intervention Group 2.

Understanding of the perspective of an aging adult (Figure 7)

In Control Group 1, just over 48% indicated that they "strongly disagreed" or "somewhat disagreed" that they understood the perspective of an elderly patient. After the simulation, over 89% of students chose "somewhat" or "strongly" agree that they understood, with no one indicating that they "strongly disagree". The paired t-test data shows that between Control Group 1 and VR intervention Group 1, the results are "extremely statistically significant".

Control Group 2 reported that nearly 47% "strongly disagreed" or "somewhat disagreed" that they understood the perspective of an older adult patient. After the simulation, 68% of respondents in VR Intervention Group 2 chose "somewhat agree", and 12% chose strongly agree. The paired t-test data shows that the comparison between pre- and post-assessments in the January group are "statistically significant".

This shows that when students embody their patient in a simulation, it causes a very large increase in students reporting an increase in their understanding and insight into the perspective of an aging patient.

Embodying patients with VR helps students learn (Figure 8)

In Control Group 1, just over 92% of respondents felt that embodying their patient would be helpful in learning concepts important to their future career, choosing either "strongly agree" (37%) or "somewhat agree" (55%). In the VR Intervention Group 1, 96% chose either "strongly agree (66%) or "somewhat agree" (32%). In January, Control Group 2 chose "strongly agree" or "somewhat agree" was 94%, and for VR Intervention Group 2, 96% chose either "strongly agree" or "somewhat agree".

A paired t-test (Table 3) was conducted to compare data between each of the groups. The results are in the table below. The assessments in Control Group 1 vs. VR Intervention Group 1 were considered "extremely statistically significant", and the Control Group 2 vs. VR Intervention Group 2 were "statistically significant".

The students who participated in the simulation already may have already had a favorable view of their participation, as evidenced by the majority of students in both control groups choosing "somewhat agree" most often, followed next by "strongly agree". However, the value of the simulation was confirmed by an average of 63% of students responding "strongly agree" in both VR intervention groups, and by the results of the t-test.

FIGURE 7. Understanding the perspective of an aging adult

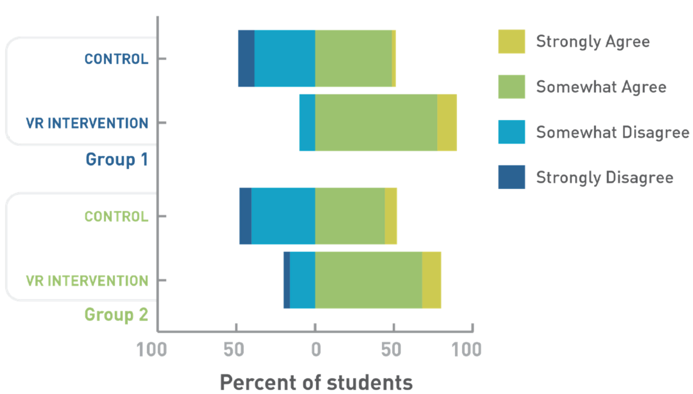


FIGURE 8. Embodying patient helps me learn concepts important to my future career

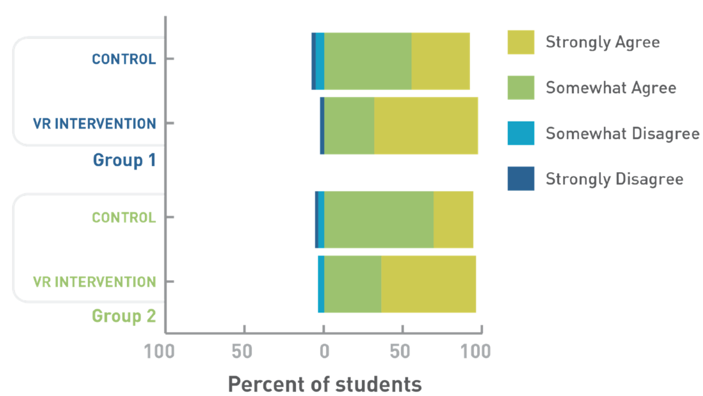


TABLE 2. Understanding the perspective of an aging adult (t-test)

	Control 1	VR 1	Control 2	VR 2
Mean	1.48	2.05	1.52	1.88
SD	0.68	0.45	0.75	0.66
Sem	0.11	0.07	0.1	0.09
n	40	40	52	50

KEY: 0 = STRONGLY DISAGREE, 1 = SOMEWHAT DISAGREE, 2 = SOMEWHAT AGREE, 3 = STRONGLY AGREE

TABLE 3. Embodying patient helps me learn concepts important to my future career (t-test)

	Control 1	VR 1	Control 2	VR 2
Mean	2.28	2.56	2.17	2.50
SD	0.69	0.68	0.58	0.64
Sem	0.11	0.11	0.08	0.09
n	39	39	52	52

KEY: 0 = STRONGLY DISAGREE, 1 = SOMEWHAT DISAGREE, 2 = SOMEWHAT AGREE, 3 = STRONGLY AGREE

Qualitative Short Answer Questions

Stereotypical words or phrases for aging adults (Figure 9)

Students were asked, "What words or phrases come to mind when you hear the words/phrases 'older people', 'elderly', 'geriatric', or 'aging?'" Most commonly mentioned stereotypical words/phrases:

- grandparent
- white hair
- nursing home
- old
- frail
- sick all the time
- wise/wisdom
- respect
- slow

Before any exposure to geriatrics-related material, 83% of Control Group 1 mentioned stereotypical words, both positive and negative, for aging adults. After experiencing the simulation, that number decreased to only 7% in the VR Intervention Group 1. In Control Group 2, 53% of students chose stereotypical words/phrases. After the simulation, that number decreased to only 4% of respondents using stereotypical words/phrases to describe aging adults in VR Intervention Group 2.

The paired t-test (Table 4) was conducted to compare data between the Control Group 1 and VR Intervention Group 1, and the data compared between Control Group 2 and VR Intervention Group 2 both show "extremely statistically significant" results.

These statistics indicate a very strong correlation between the The Alfred Lab and the decrease of stereotyping for aging adults.

FIGURE 9. Stereotypical words/phrases for aging adults

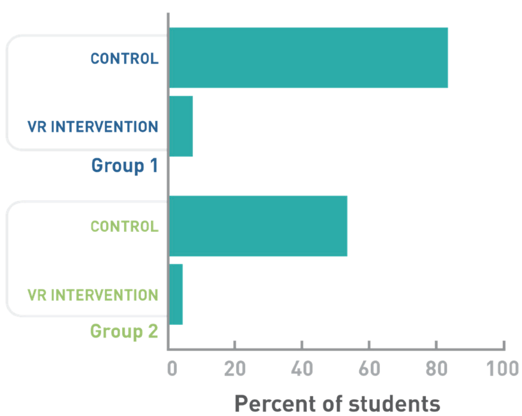


TABLE 4. Using stereotypical words to describe aging adults (t-test)

	Control 1	VR 1	Control 2	VR 2
Mean	2.58	0.25	3.58	0.33
SD	2.11	0.45	2.15	0.65
Sem	0.61	0.13	0.62	0.19
n	12	12	12	12

KEY: 0 = STRONGLY DISAGREE, 1 = SOMEWHAT DISAGREE, 2 = SOMEWHAT AGREE, 3 = STRONGLY AGREE

Skills physicians need to assess and care for elderly patients

In Control Group 1, at least three students listed each of the following adjectives as important: empathy, patience, understanding, compassion, kindness, and communication. The first three on that list were mentioned by an average of about 40% of the group, and continued to be by far the top three listed by the learners in Control Group 2 and both VR Intervention groups. In Control Group 2, the following two adjectives/phrases were added to that list: "attentiveness" and "complexity of care". In Control Group 2, "respect", "flexibility", and "positivity" were mentioned, along with all other adjectives listed thus far. VR Intervention Group 2 had no new adjectives, with at least two students mentioning all of the adjectives listed above. This indicates that the simulation may help learners understand a more complex view of the attitudes and skills needed for geriatrics medicine, but that the internalization of these concepts is complex and can be attributed to many factors.

Morbidities physicians should consider that may affect cognitive test results

For all groups, the top three morbidities that students listed as important were cognitive/memory issues, hearing impairments, and visual impairments. In Control Group 1, these were nearly equally split between the three, with a slight emphasis on cognitive issues. In Control Group 2, about 65% of students prioritized cognitive impairments. In VR Intervention Groups 1 and 2, at least three students mentioned "motor skills", though about 80% of students prioritized hearing and vision. This indicates that the simulation helped bring more attention to the hearing and vision impairments, and the slight increase in students mentioning "motor skills" after the simulation indicating that embodying a patient helps students see a more holistic picture of the factors that could affect a cognitive test.

DISCUSSION AND CONCLUSIONS

This pilot study sought to evaluate whether embodying a patient in The Alfred Lab would lead to greater empathy, a better understanding of the pathologies that affect aging adults, and more interest in pursuing a geriatrics specialty among 2nd year medical students.

The results suggest that The Alfred Lab does have a significant effect on the ability of learners to take the perspective and empathize with older adults, as shown when an average of 30% more students chose "strongly agree" or "somewhat agree" in both of the VR intervention groups when asked if they understand the perspective of an aging patient. These results show strong support for the Embodied Labs framework and add credence to the theories of embodied cognition and embodied learning, though further studies are needed to validate the difference between perspective-taking after more traditional lecture methods vs. an embodied simulation like The Alfred Lab.

The results also suggest an increase in students interested in choosing a geriatrics career after experiencing our simulation, even though the t-test did not show a strong correlation. An average of 9.5% more students reported being “somewhat interested” in a geriatrics specialty after the VR intervention. In a class of 200 students, that means that nearly 20 more students are considering geriatrics who previously were not. Even this relatively small percentage could have far reaching implications for the aging population in the United States.

In addition, the results do indicate that the simulation helps students internalize and learn concepts that help them gain a better understanding of pathologies that are common with the older adult population. Before the simulation, most students said that empathy, understanding, and patients were important, but post-simulation they used many more words that indicated they had a better understanding of the complexities associated with aging, in addition to the need for more attentive doctors with good communication skills. Additionally, after the VR intervention students had a more holistic perspective of what could affect the ability of an older adult to complete a cognitive test, such as motor skills and audiovisual problems – not just cognitive and neurological disorders.

Finally, the results that are most clearly tied to the direct influence of the simulation was the drastic drop in student’s use of stereotypical words and phrases to describe older adults. While 83% of students in Control Group 1 and 53% of Control Group 2 used stereotypical words/phrases, only 7% of Intervention Group 1 and 4% of Intervention Group 2 used these words in the post-assessment. Replacing them were words like “frustrating”, “misunderstood”, “isolated”, and “just like us”, clearly showing that students had drastically changed their point of view after embodying Alfred in The Alfred Lab. Further studies are needed to better explore the comparison between decrease of stereotyping in traditional lecture vs. embodied simulations like The Alfred Lab.

The implications of this pilot study are far reaching. Medical students are not the only learners who can benefit from embodying their patients. Nurses, CNAs, assisted living staff, family care partners, and more would be able to drastically change their knowledge, beliefs, and attitudes about aging adults. Further studies are needed to evaluate patient satisfaction and outcomes as a result of healthcare students and professional participating in an Embodied Lab or other training based in the theories of embodied learning.

The implications of this study both for the elder care crisis facing the United States, as well as the evidence that embodiment shatters traditional stereotypes that the learners held regarding aging and being old, deserve further investigation by Embodied Labs and other companies who are involved in creating learning tools based in embodied cognition, and those who are experts in embodied cognition and the learning sciences.

In addition to the learning outcomes of the simulation that were evaluated in this pilot study, the skills that participation in this simulation improves (empathy, communication, teamwork, technology literacy, and community) are all skills identified in the 21st century career ready practices. We need a robust workforce who can be empathetic, skillful, and knowledgeable caregivers and healthcare providers, capable of being attentive communicators. Embodied learning through software like The Alfred Lab is a powerful tool to teach those skills.

The Embodied Labs software has been used in Australia, London, the Netherlands, and the United States. We offer a limited free trial for key individuals to try the simulation before subscribing to the software. For some customers, the cost of the hardware has been an economic barrier, given that one complete set of hardware costs a minimum of $1,300. While mobile VR is slightly more cost effective, it cannot currently support hand tracking and real time rendered elements necessary to deliver our simulation. However, we have the beta SDKs for up and coming mobile solutions and are building our simulation and platform to adapt to these when they become available.

Logistical requirements for target users to run our simulation require that the institution has a designated area where the VR hardware can be set up and used for the duration of the course. In past use cases, our prototype has been successfully hosted in a library, central to multiple departments within an academic institution and a simulation center that is accessed by a range of applied health science programs. From a technical standpoint, a designated IT person is recommended be present to do a one-time setup of the hardware and software, then remain available to answer questions and make updates on the hardware as needed. We have created a user manual that explains the entire setup process and a recommended “VR kit” to guide users with their equipment purchases. A tutorial embedded within our Embodied Labs application guides the learner through a simple VR setup before beginning the simulation. It is our priority to build the simulation such that minimal ongoing set up and/or instruction is needed outside of the application.

Embodied Labs is looking for partners who consider themselves innovators, champions of using new technology, and leaders in utilizing novel training methods. We want to work with educational institutions, healthcare systems, hospitals, home health agencies, and public health organizations. We will continue to build partnerships with our customers in order to carry out and co-publish rigorous longitudinal, peer-reviewed research studies that assess the efficacy of our simulation and the embodied framework, as well as to determine its effect on care provider performance and patient satisfaction.

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