Virtual reality learning environments for materials education

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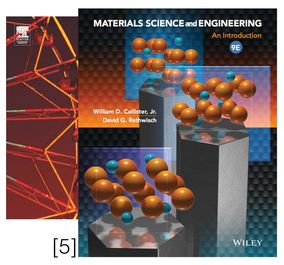
Abstract: Virtual Reality (VR) is defined as "a high-end user-computer interface that involves real-time simulation and interactions through multiple sensorial channels." Specifically, head-mounted displays (HMDs) as VR systems stream a virtual 360° environment via screens in front of users' eyes and track the user motion. Therefore, VR is a platform for students to experience a Virtual Learning Environments (VLEs) that are designed by materials educators to teach a specific topic. These VLEs have the potential to revolutionize materials education by providing heretofore unexplored immersive learning environments. With the decreasing prices of VR systems, educators have a great opportunity to offer one of the most exciting ways to interact with learners in a designed way. Despite the increasing use of VLEs, however, literature has conflicting reports on both the benefits and disadvantages of learning in VR. These conflicts and gaps in the knowledge led us to our long-term goal to discover the design guidelines for effective teaching in VR. We address part of the knowledge gap related to learning in VR considering segmentation principle, multimedia principle, coherence principle, Yerkes-Dodson law, Kolb's model of experiential learning, and motivational theories. Here, we present two VLEs to teach materials/ mechanical engineering concepts. These VLEs deliver concepts on tensile testing and Poisson's ratio. We used Unity 3D to develop the VLEs. An HTC Vive system was used to perform a pilot study on ~30 students. Our preliminary data shows that students learn better in VR, but more studies are needed to identify the efficiency of teaching materials in VR.

Traditional teaching does not

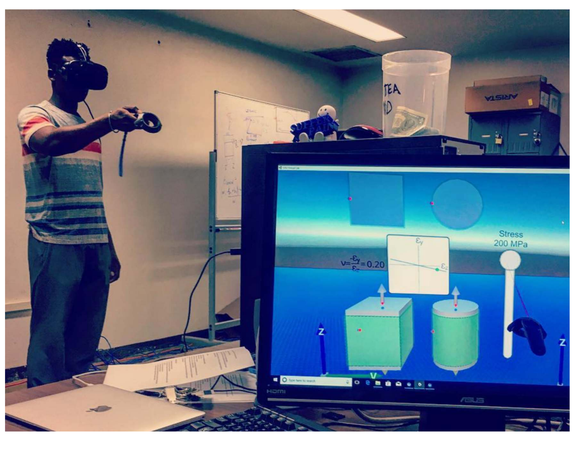


[5]

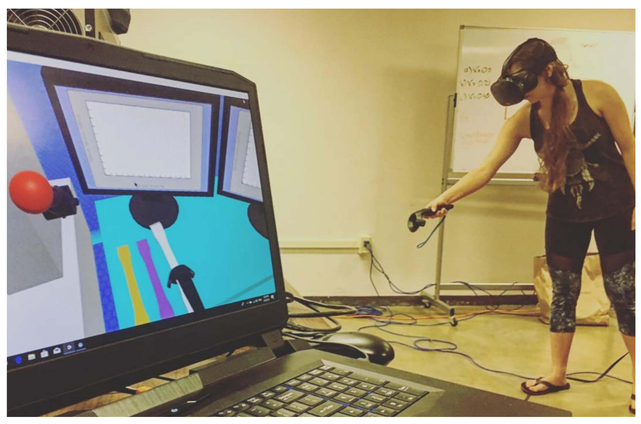
- motivate
- engage
- interest
- teach

as well as VR teaching [1-3].

VR teaching is not as effective as traditional teaching [3-4].



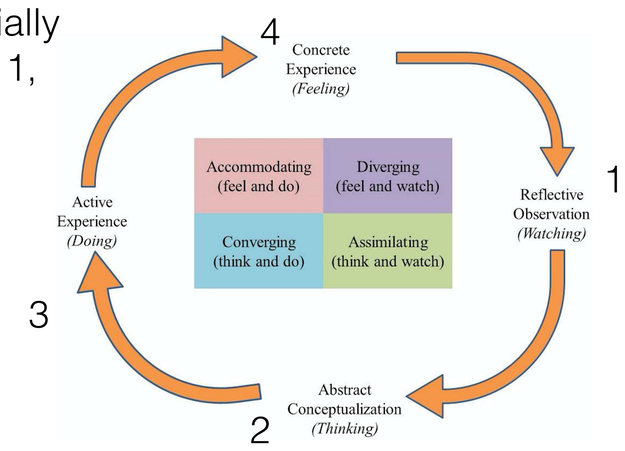
Solution: Put screens in front of eyes (!)



Not an easy solution.

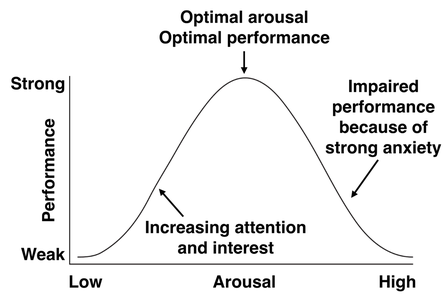
Kolb's experiential learning [6]

VR potentially enhances 1, 2, and 3.



Yerkes-Dodson law [7]

Reduce student excitement.

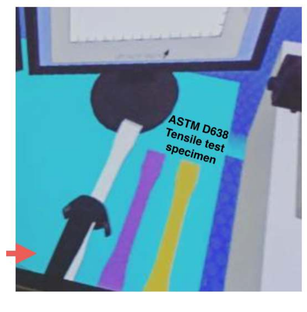


Mayer's 12 principles of multimedia learning [8]

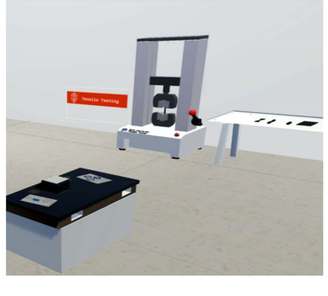
Reduce students' cognitive load.

Segmentation principle
Self-paced
Short segments

Multimedia principle
Personalized narration
Words & pictures together

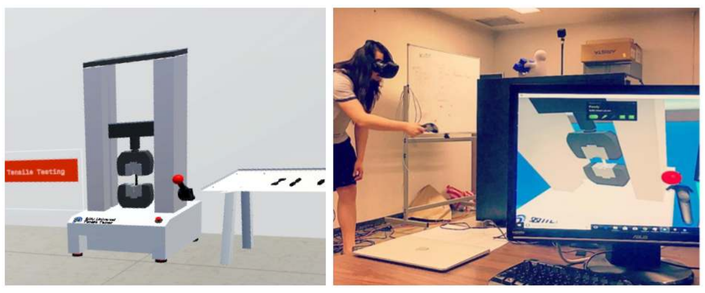


Coherence principle
No extraneous material
No unneeded words

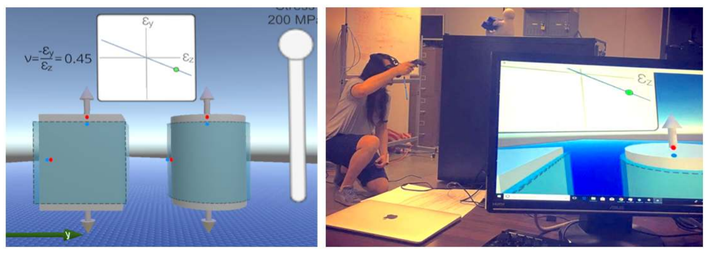


Solution: Personalized iteratively designed virtual learning environments (VLEs)

Tensile testing VLE

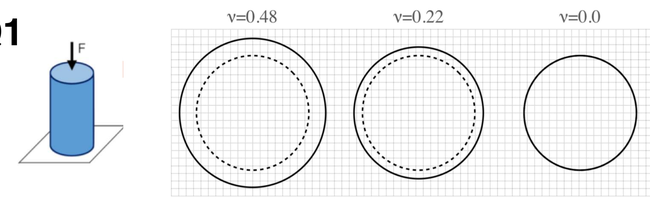


Poisson's ratio VLE

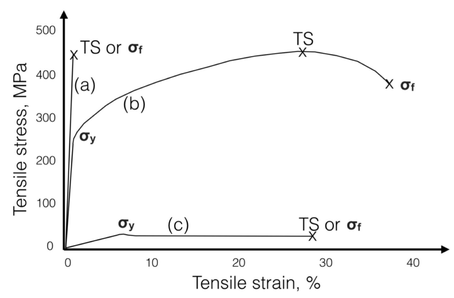


Preliminary tests using VLEs

Q1



Q2



	N	Q1 (9 pt.)	Q2 (12 pt.)
VR	12	6.3 ± 3.5	6.7 ± 3.0
Non-VR	23	5.0 ± 3.8	5.3 ± 3.8

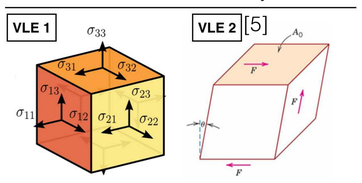
Future study

Apply the best practices in three sessions and test.

Session 1
Initial VR session
Reduce excitement

Session 2

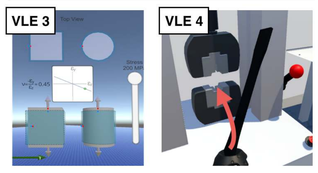
Stress cube Rotation matrix | Strain in machine components



[5]

Session 3

Effects of Poisson's ratio | Tensile testing of materials



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