



Investigating student and faculty attitudes and perceptions towards using Virtual Reality (VR) to improve Computational Thinking (CT) levels in Cybersecurity-Additive Manufacturing (CAM) training

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**Presentation
by**

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Outline

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Background- Emerging Technologies

Immersive Virtual Reality

VR immerses users in a computer-generated three-dimensional environment.

The CAVE (Cave automatic virtual environment) and Head Mounted Display devices (HMDs).



Internet of thing (IoT)
Network of smart devices.



Cloud computing

Allows system integration and process automation..

Artificial Intelligence (AI)

Intelligence demonstrated by machine using data science.

Additive Manufacturing (AM)

Three-dimensional printing that creates models in small layers at a time.

Problem Statement

The problem is national crisis in Science, Technology, Engineering, Mathematics (STEM) due to limited technological training to meet industry demands.

National crisis in STEM

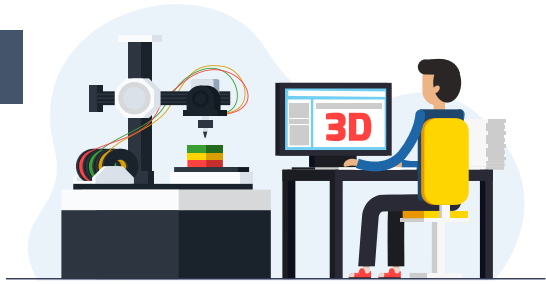
- Technical literacy.
- Diversity and inclusion in STEM fields.
- Limited virtual reality (VR) and computational thinking (CT) literature in Historically black colleges and universities (HBCUs).

(Pellas et al., 2020; Radianti et al., 2020; T et al. 2020)

National Science Foundation priorities

- Investing in STEM research and development.
- Upskill STEM Workforce.
- Foster Problem solving capabilities like CT.
- Increase diversity and inclusion in the STEM industry.

(NSF reports, 2021)



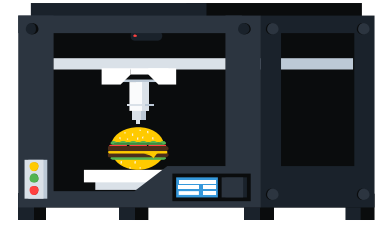
Benefits of Additive Manufacturing (AM)

CAM

Importance of CAM training

Literature Overview – CAM

- The use of Computer Aided Design (CAD) facilitates collaboration within AM.
- Simplifies the production process from conception to manufacturing.
- AM is suitable for rapid prototyping.
- Model designs can be visualized and manipulated using Virtual Reality (VR).



(Renner et al., 2015).

- As an internet-based system, AM systems are susceptible to cyber-attacks.
- A cyberattack on AM targets CAD files, sensors, actuators, and controls

(Calderón & Izquierdo, 2020; Corallo et al., 2022; Mahesh et al., 2021)

- Cyberattacks targeting infrastructure are a major concern for the United States.
- Cybersecurity is an essential component of national security and economic growth.
- STEM education is crucial for the development of the next generation of STEM professionals.

(Corallo et al., 2022; Mahesh et al., 2021)

Literature Overview – Computational thinking (CT)

Definition

- Set of thinking and problem-solving skills derived from computer science.
- Frequently used words describing CT include **abstraction, problem-solving, and algorithmic thinking.**



Framework

- Decomposition
- Abstraction
- Algorithmic Design
- Pattern recognition



Implementation

Fostering CT in STEM education using:

- Active learning.
- Project-based learning.
- Problem-based learning.
- Coding and robotics activities.



Assessment

- Observation, performance tasks, and surveys.
- CT survey scale by Korkmaz : five-point Likert scale with 29 observable variables that can be measured under five factors.
- Five factors- **creative thinking, algorithmic thinking, critical thinking, problem-solving skills, cooperative thinking.**



Literature Overview – Virtual Reality (VR)

Benefits

- Foster student engagement, motivation, skills acquisition, academic performance.
- Foster cognitive abilities, digital skills, and soft skills
- Visualization, immersion, interactive.



Learning Paradigm

- Behaviorism - Classroom management, student-centered.
- Cognitivism – Active learning.
- Constructivism - Experiential and interactive pedagogy.



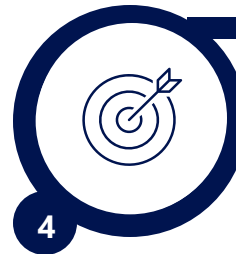
Framework

- Virtual Environment.
- User interface.
- Tracking system.



Learning Theory

- Cognitive Theory of Multimedia Learning.
- Experiential learning.



Instructional Design Framework.

- Interactive.
- Collaborative.
- Gamification elements.

Gap in literature



01

Limited research on VR and CT conducted in HBCUs.

02

There is little systematic research on immersive VR in higher education, especially engineering education.

Statement of purpose



To **examine** the student and faculty perceptions and attitude to the use of immersive VR in the curriculum.

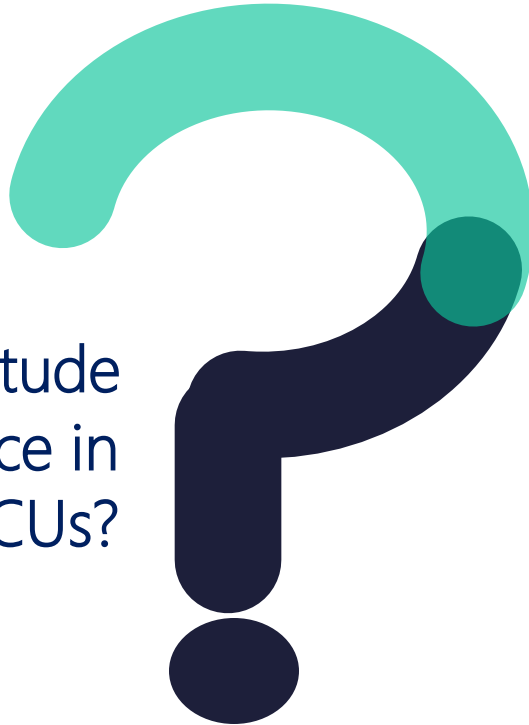
Research Questions

RQ1

What are student and faculty attitude and perceptions towards VR space in CAM training at HBCUs?

RQ2

What are student and faculty attitude and perceptions towards using VR space to develop CT in CAM training at HBCUs?



Significance and Contribution



A

Virtual Reality

Research evidence of the effectiveness of VR in improving CT capabilities..



B

Literature

Contribute to CT development literature.



C

Technology Policies

Improve practices and policies in integrating VR in STEM education.



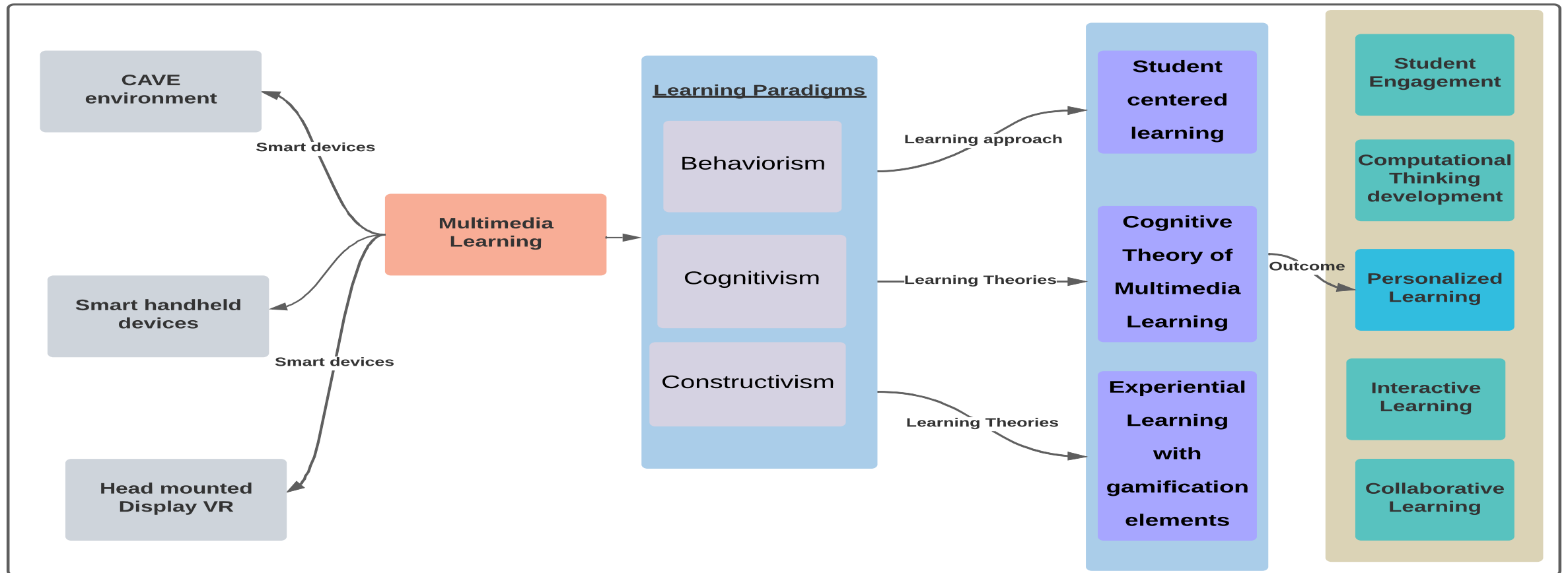
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CT development

Provide information for practitioners and educators on CT development.

Conceptual Framework

Adopted from the Cognitive Theory of Multimedia Learning and Experiential Learning.



Research Design

Approach

Qualitative method

AIM

• To gain in-depth understanding of participants perception, attitude, and behavior towards the use of immersive VR in the curriculum to enhance learning.

Research design

• Cohort observational study.

Participants

• The study took place in an HBCU.
• 38 students enrolled in first year engineering class (freshman engineering 120).
• 4 faculty member.

Data Collection

• Face-to-face in-person interview, focus group interview, direct classroom observation.

Data Analysis

• Thematic coding.

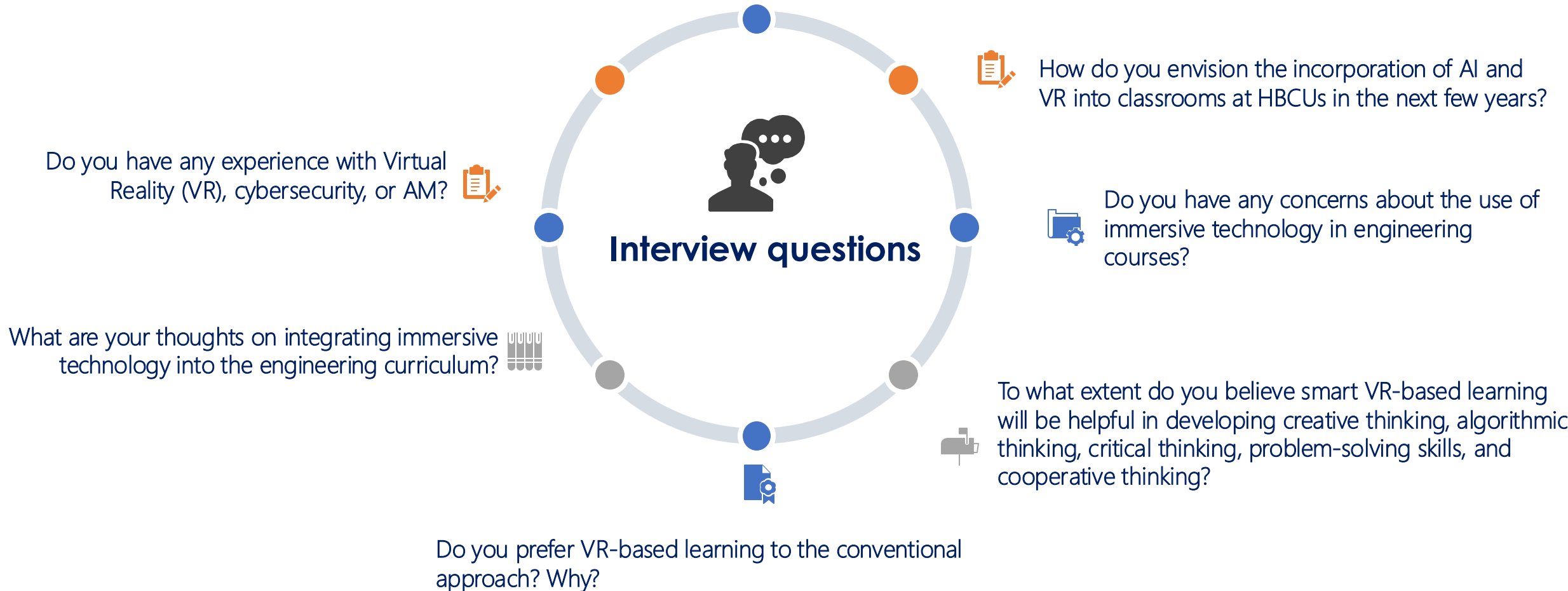
Data collection procedure – Students

- Two direct classroom observations sessions using an observation protocol.
- Each observation lasted approximately 60 minutes.
- Five focus group interviews containing 5-8 participants after exposure to the VR space.
- Each focus group interview lasted approximately 10 minutes.



Data collection procedure – Faculty

- Face-to-face in-person interviews.
- interview lasted approximately 10 minutes.



VR space setting

Classroom Setting

Flipped classroom setting.

The instructor collaborated with the VR space facilitator to present VR models to students.

Class Content

Introduction to the VR space and its benefits in AM and engineering design was presented at the start of the CAVE session.

Students were required to submit reflective assignments in the form of an essay, a presentation, a class forum, or a portfolio.

LEARNING OBJECTIVES

- Visualization tools.
- Computer Aided Design (CAD).
- 3D printing.
- Cyber-physical systems.
- Identify and defend against threats.

VR activity

Each group of 8 students spent approximately 15 minutes interacting with three-dimensional models.

The students viewed three VR models and manipulated 3D models by grabbing, rotating, zooming, and dropping it.

Data Analysis procedure

Thematic Coding



Results R1 – Faculty

Perception and Attitude – Positive

- › VR should be incorporated into the STEM curriculum to ensure that students are adequately prepared for the workplace.
- › VR has a positive impact on student engagement and motivation to pursue STEM-related careers.
- › VR is important in developing CT capabilities.
- › VR-based learning should be used in conjunction with face-to-face learning.

Concerns

- Ethical, licensing, and data privacy issues. - using the VR space in a clean and appropriate manner.
- Limited technical skills among educators in creating VR applications.
- Accessibility.
- Need for a well-planned roadmap for incorporating VR into the classroom.



Quotes

"My thoughts. My thoughts are it's needed. We know that research shows that active learning is a lot better than students just reading things from the book. So an immersive experience basically antes up that whole active learning phenomenon".

"In my experience, it forces the students to re-imagine or re-envision the topic, the concept, and what they're actually learning."

"The CAVE environment that it is going to really build your ability to understand that spatial reasoning, which is something that probably means nothing to you right now, especially where you are as your trajectory and your matriculation is future engineers

" But you know VR based learning expands the mind. I mean you can get inside of. For example, we have a space station model that you can actually make a tour through it. You can actually get the sensation that you're out in space and looking down to Earth. So it expands your thinking and adjust how you see things, your perception as to what's really happening, you don't get that exposure with other technologies",

Results R2 – Students

Observation

- › Highly engaged and interested in the CAVE environment.
- › Constantly collaborating, asking questions and contributing creative ideas.

Quotes

"It was pretty cool"

"I would say it was pretty unique. I have not been in virtual reality CAVE before. I have experienced virtual reality in game before, but I never did anything like that. I thought that was pretty cool"

Perception and Attitude – Positive

- › VR is unique and realistic experience.
- › VR as a helpful tool for developing practical skills, safety habits, and real-world problem-solving abilities.
- › Enhance experiential and active learning, which is conducive to CT development.



"it can help us improve our practical skills and safety habits and all that."

"Well, like I said, it's just basically putting them in real world situations. Like I can say these. This right here, yeah, we can create a model and break it apart and make us learn it piece by piece and bring it back together and learn the functionalities of the parts."

"I mean it help in putting on real life situation without actually spending more. That's how it will help because you can learn, you can make mistakes without messing anything up or, you know, damaging anything that costs a lot of money. You can make those mistakes early, so when you finally do get into the field its going to be perfect."

Concerns

- Dizziness.

Conclusion

1

Participants demonstrated high engagement and interaction levels and a positive attitude towards the VR space.

Future work – Quantitative method to investigate the relationship between VR space and CT development

4

2

Students were highly engaged, creative, cooperative, critical thinkers, and eager to learn new challenging things in the VR environment.

VR in the engineering curriculum was seen as a valuable tool in improving students' learning experience and CT skills

3



**THANK
YOU**

