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Protecting Our World, Conquering New Frontiers

Collaborative Virtual Reality for Surveying Education

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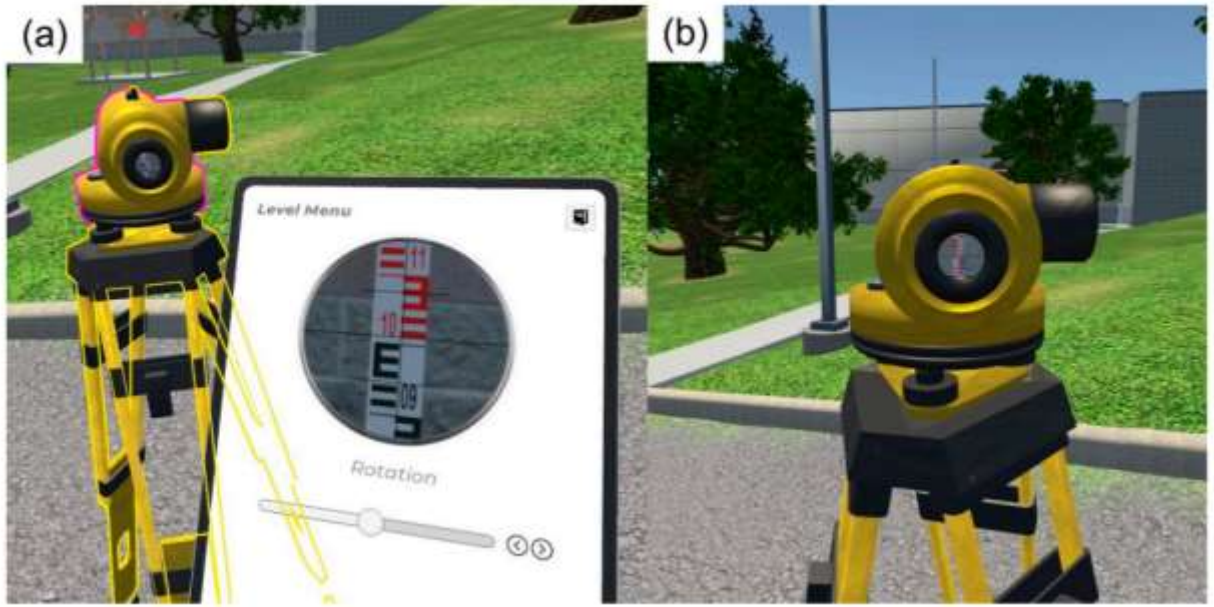
Intro / Motivation

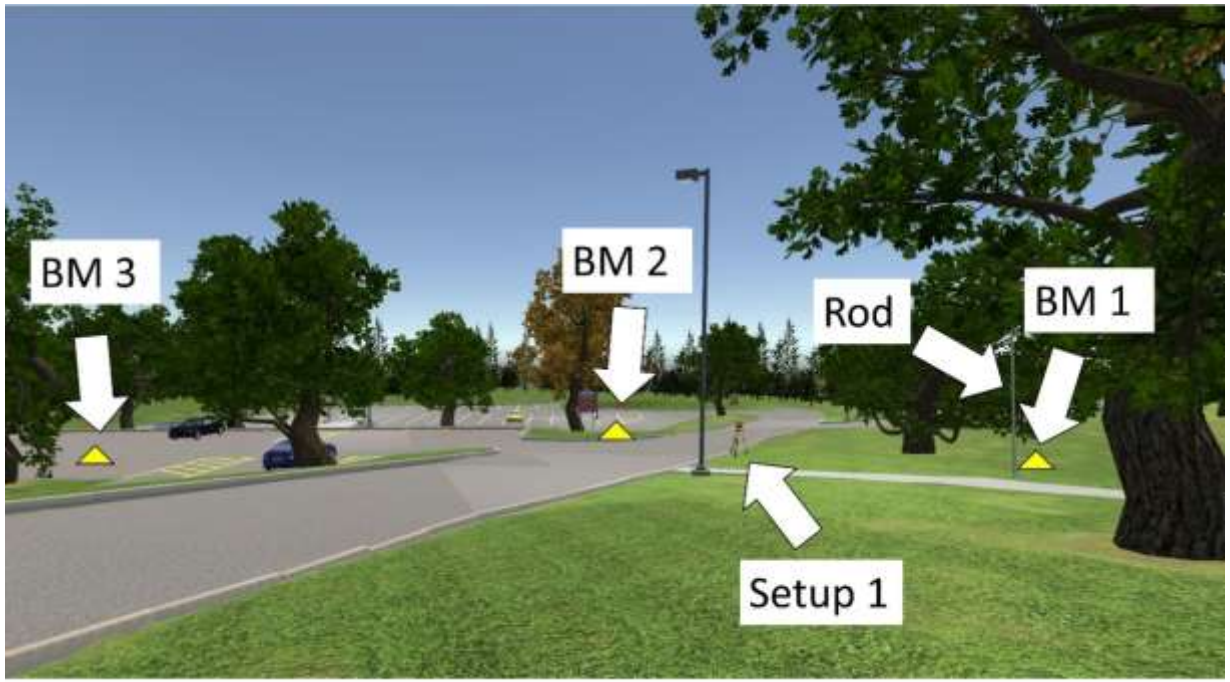
- Many VR implementations focus on assessment of longstanding objectives
- Pedagogical structures are often not clearly addressed
- Theoretical Framework of VR applications
  - Direct instruction – tutorials, presentations, drill, and practice
  - Experiential learning – real-life or virtual experience, learn by doing
  - Discovery learning – discovery, inquiry, problem solving and decision making
  - Situated cognition – students are observers and actors, engage in social interactions, work as a team to solve problems
  - Constructivism – making sense of experiences, students act, experiment and reflect within the experiences

Objectives

- Situated cognition: context-based collaborative learning, transferring of knowledge and skills between learners, and simulates real-world learning settings
- Teamwork, engaging in technical and diverse discussion, learning from peers and/or instructors, and collaborative learning are integral to engineering
- **We implemented situated cognition VR surveying labs**
- **Can situated cognition support and assist learning of surveying engineering principles in activities that are designed in immersive and interactive VR?**

The VR Lab (SurReal Software)





VR Implementation

In class lectures and demonstrations

- Virtual Reality: Experiential Learning
  - Student uses both instrument and rod
- Virtual Reality: Situated Cognition / Collaborative learning
  - Two students per group, one uses the instrument and one the rod (but they can switch)

Student receives report and reviews mistakes → Physical lab

One student assumed a leadership role, while the other took a follower role

Technical Results

- Two minds are better than one!
- Fewer mistakes and less time needed

	Achieved <1 cm misclosure	Blunder / mistake	Did not finish	Average distance balancing	Wrong field book format	Average time
Experiential learning	2/6	2/6	**2/6**	6.5 m	**3/6**	**44.8 min**
Situated Cognition / Collaborative learning	2/4	2/4	0/4	5.0 m	0/4	24.0 min

Pre-test and Post-test Results

- No significant difference between the two methods - both methods can support surveying education
- Comparisons with years without VR show a significant difference in favor of the VR technology

Assessment method	Experiential Learning (*n*=6)	Situated Cognition (*n*=8)	Significance
Pre-test	43.1%	46.0%	No
Post-test (leveling questions)	88.9%	88.1%	No
Post-test (all questions)	90.4%	88.9%	No
Physical leveling lab	92.5%	95.0%	No

Comparison with Previous Years

- Positive effect in student grades when VR is used

Assessment method	2016 (n=11)	2017 (n=9)	2018 (n=11)	2019 (n=7) (VR)	2020 (n=9)	2021 (n=14) (VR)
Lab (Three-benchmark loop)	89.5%	86.7%	79.6%	**99.0%**	84.4%	**91.8%**
Lab (Benchmark-to-benchmark)	90.5%	86.7%	84.7%	**87.6%**	Not conducted	**93.9%**
Midterm (selected numerical problem on leveling)	59.1%	65.9%	No data	**71.4%**	No data	**90.7%**
Midterm (overall grade)	80.3%	79.4%	81.1%	**83.0%**	81.8%	**89.8%**

Peer-to-Peer evaluations after the physical lab

- Q1 and Q3 yield statistically significant differences
- Positive effect of the situated cognition labs on student collaboration

	Q1: Demonstrates good and encourages communication among teammates	Q2: Demonstrates participation in decision making	Q3: Demonstrate active team member participation in assigned-role duties
Experiential learning	4.4	4.6	4.4
Situated Cognition / Collaborative learning	**5.0**	4.9	**5.0**

Conclusions

- Integration of VR under a theoretical framework
  - (1) experiential learning and (2) situated cognition / collaborative learning.
- **We find no significant difference between the two VR implementations**
- Comparisons with years without VR shows a significant difference in favor of the VR technology.
- We found a significant difference in the teamwork peer-to-peer evaluations in physical labs → situated cognition can enhance teamwork skills.

References

- If you want to learn more about our VR work:
  - Bolkas, D., Chiampi, J., Chapman, J., & Pavill, V. F. (2020). Creating a virtual reality environment with a fusion of sUAS and TLS point-clouds. International journal of image and data fusion, 11(2), 136-161.
  - Bolkas, D., Chiampi, J., Fioti, J., & Gaffney, D. (2021). Surveying reality (SurReal): Software to simulate surveying in virtual reality. ISPRS International Journal of Geo-Information, 10(5), 296.
  - Bolkas, D., Chiampi, J. D., Fioti, J., & Gaffney, D. (2022). First assessment results of surveying engineering labs in immersive and interactive virtual reality. Journal of Surveying Engineering, 148(1), 04021028.
- If you want to learn more about pedagogical foundations and situated cognition:
  - Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. Educational researcher, 18(1), 32-42.
  - Johnston, E., Olivas, G., Steele, P., Smith, C., & Bailey, L. (2018). Exploring pedagogical foundations of existing virtual reality educational applications: A content analysis study. Journal of Educational Technology Systems, 46(4), 414-439.
  - Kebritchi, M. & Hirumi, A. (2008). Examining the pedagogical foundations of modern educational computer games. Computers & Education, 51(4), 1729-1743.

Thank you!

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