PennState Behrend

Connected Learning and Integrated Course Knowledge (CLICK) Approach
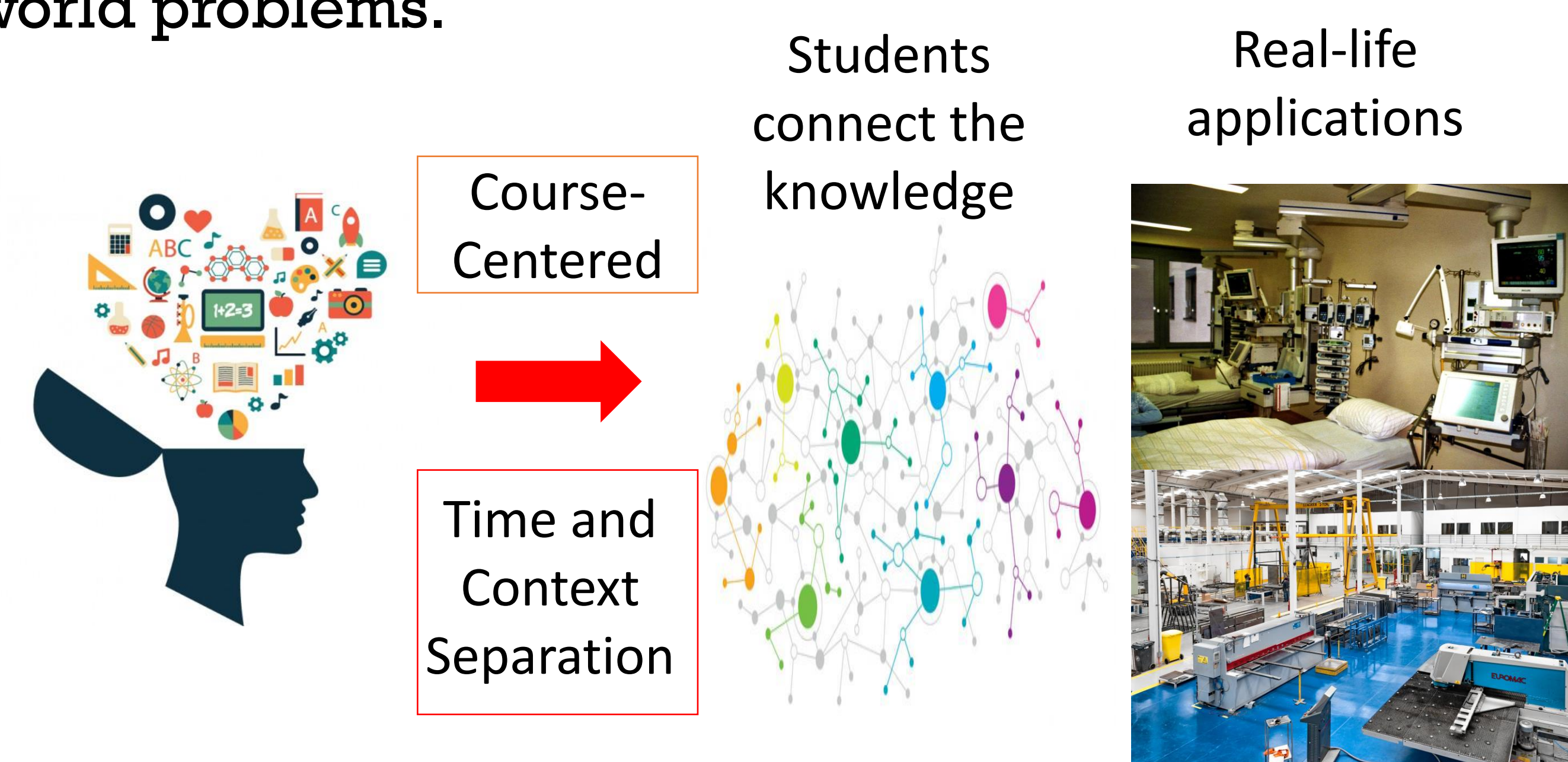
NSF

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COLLABORATORS

Omar Ashour, Penn State Behrend;
Christian Lopez, Lafayette College;
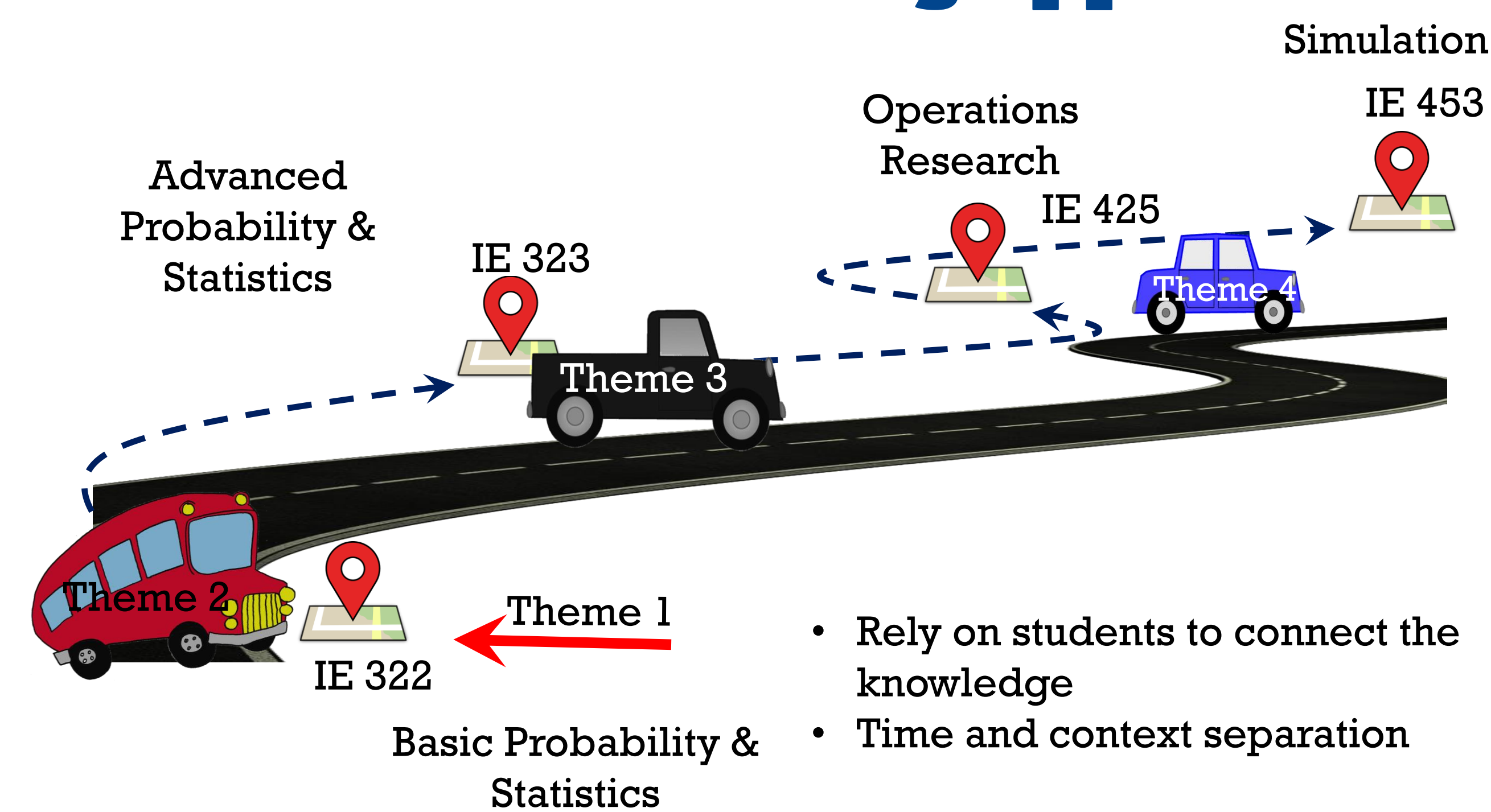Conrad Tucker, Carnegie Mellon University;

BACKGROUND

Curriculum is limited in its ability to establish connection between fundamental topics as well as real-world problems.
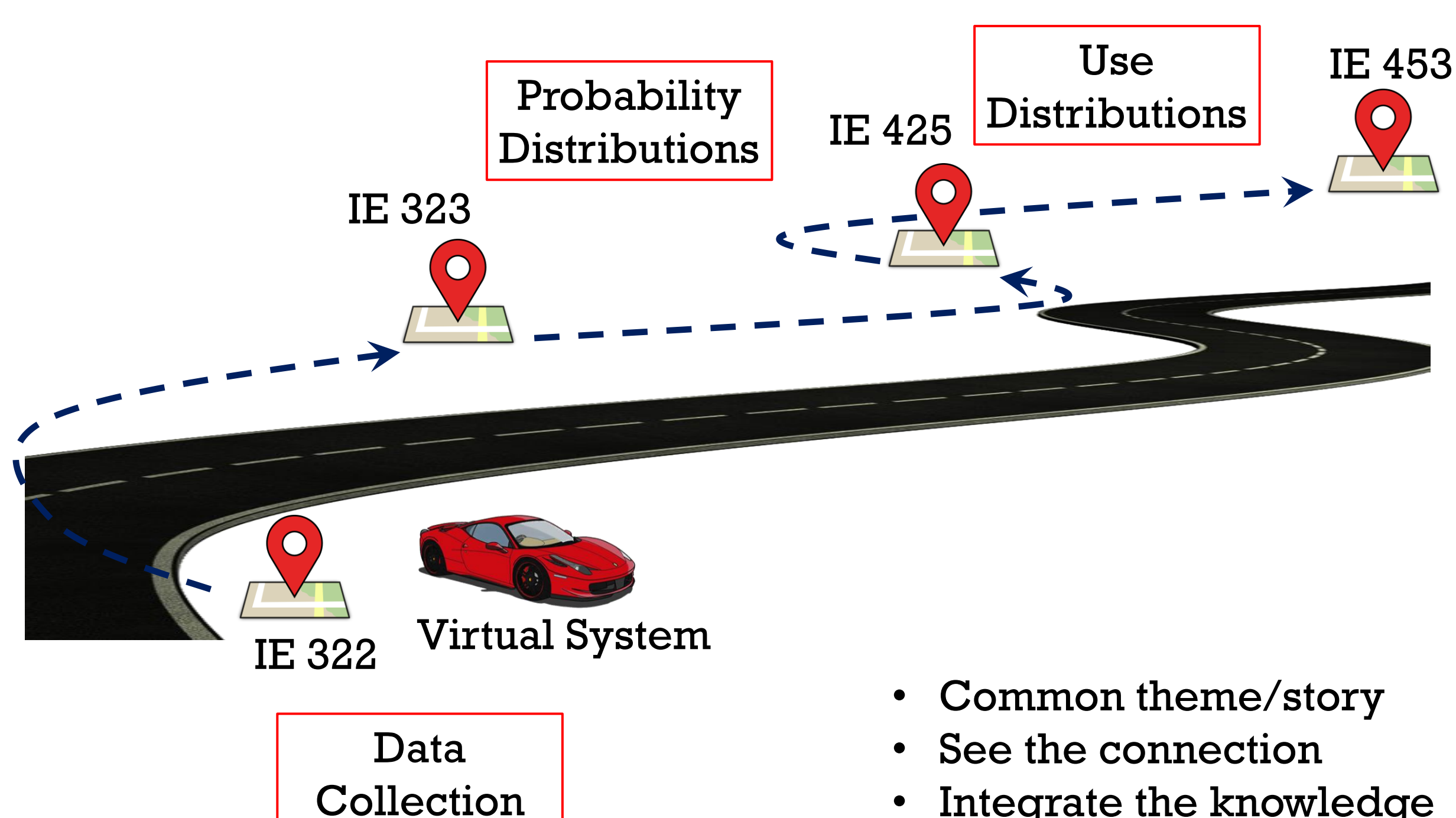

Course-Centered → Time and Context Separation

Students connect the knowledge

Real-life applications

Responsibility of connecting and transferring the knowledge between courses should not be on the students (Maciejewski et al., 2017)

Traditional Teaching Approach

Advanced Probability & Statistics — IE 323 — Theme 3

Operations Research IE 425 — Theme 4

Simulation IE 453

Theme 2 — IE 322 — Theme 1

Basic Probability & Statistics

- Rely on students to connect the knowledge
- Time and context separation

Connected Learning and Integrated Course Knowledge (CLICK)

Probability Distributions — IE 323 — IE 425

Use Distributions — IE 453

IE 322 — Virtual System

Data Collection

- Common theme/story
- See the connection
- Integrate the knowledge

ABSTRACT

Need

This poster presents the results of the NSF project entitled Leveraging Virtual Reality (VR) to Connect Learning and Integrate Course Knowledge (CLICK) in the Industrial Engineering Curriculum (award #1834465). The project aims to address the problems in the current curriculum structure as well as challenges related to immersive technologies. The traditional course-centric curriculum structure fails to connect the fundamental topics that the students need to master and use to solve real-world problems.

Guiding Questions

The project is addressing the following research questions: 1) how the CLICK approach can be used to integrate the Industrial Engineering curriculum; and 2) What is the effectiveness of immersive technology (VR and 3D simulation models) in improving students' motivation, engineering identity, and learning outcomes.

Outcomes

The project resulted in developing VR and 3D simulation environments. These environments were used in four IE courses including probability and statistics, operations research, and discrete-event simulation. Experiments were carried out in these courses and the results of these experiments have been published in several conferences and journal publications. The CLICK approach has improved students' motivations and engagement in the classroom. It should be noticed that the original experiment setup was interrupted by COVID-19 and the sudden shift to online learning over the last 2 years.

Broader Impacts

The proposed approach can improve the students' understanding of the "big picture" of how concepts taught in the IE curriculum fit together. Better understanding leads to more motivation, persistence, and retention as well as better engineering graduates. The project efforts have resulted in developing virtual systems and instructional material that can be used by others to teach IE concepts. The resulted approach provides the foundation for curriculum integration using virtual systems that leverage immersive technologies. In addition, this effort provides the foundation for deeper investigation and wider expansion of the proposed approach across the entire higher educational system as well as the pre-college system. The results have been disseminated in several conferences and journal publications including ASEE, ASME IDETC, STEM for ALL Multiplex, and the Journal of Computing and Information Science in Engineering.

METHODS

Learning Modules

The interfaces used to study the effects of immersive technology include Virtual Reality (VR) and Simio 3D-Simulation-based learning modules. The figures below show the manufacturing systems built with Unity (VR) and Simio (3D simulation model), respectively.
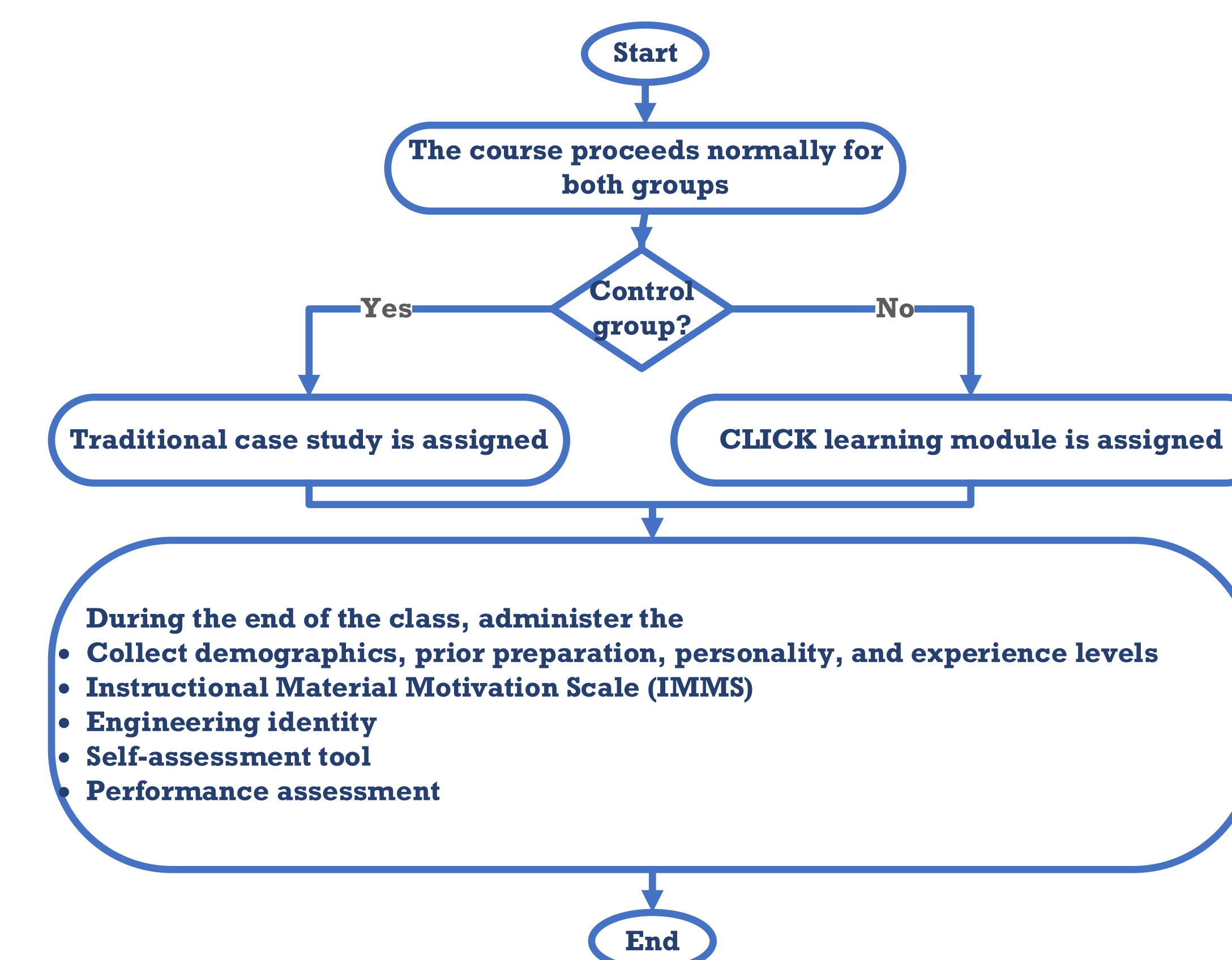

VR in Unity

3D Simulation in Simio®

Experiments Setup

Start

The course proceeds normally for both groups

Control group?
- Yes → Traditional case study is assigned
- No → CLICK learning module is assigned

During the end of the class, administer the
- Collect demographics, prior preparation, personality, and experience levels
- Instructional Material Motivation Scale (IMMS)
- Engineering identity
- Self-assessment tool
- Performance assessment

End

Results

- Immersive technology learning modules have increased students' motivation.
- No significant effect on engineering identity.
- Self-assessment is positively correlated with the instructor assessment, motivation, and engineering identity.

PUBLICATIONS

Lopez, C., Cunningham, J., Ashour, O., & Tucker, C. (2020). Deep Reinforcement Learning for Procedural Content Generation of 3D Virtual Environments. *Journal of Computing and Information Science in Engineering*.

Ashour, O., Seamon, A., Lopez, C., Ozden, S.G., DiFrancesca, D., & Tucker, C. (2022). "A Study on the Effectiveness of using Integrated Nonlinear Storytelling and Simulation-based Learning Game in an Operations Research Course." *American Society for Engineering Education (ASEE)*.

Cunningham, J., Ashour, O., Lopez, C., & Tucker, C. (2021). "Connected Learning and Integrated Course Knowledge (CLICK) Approach." *American Society for Engineering Education (ASEE)*.

Lopez, C., Ashour, O., Cunningham, J., & Tucker, C. "A Study on the Effectiveness of the CLICK Approach in an Operations Research Course." *American Society for Engineering Education (ASEE)*.

Cunningham, J., Lopez, C., Ashour, O., & Tucker, C. (2020). "Multi-Context Generation in Virtual Reality Environments using Deep Reinforcement Learning." *ASME 2020 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference (IDETC/CIE 2020).*

Lopez, C., Ashour, O., Cunningham, J., & Tucker, C. (2020). "The CLICK Approach and its Impact on Learning Introductory Probability Concepts in an Industrial Engineering Course." *American Society for Engineering Education (ASEE).*

Lopez, C., Ashour, O., & Tucker, C. S. (2019). "Reinforcement Learning Content Generation for Virtual Reality Applications." *ASME 2019 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference (IDETC/CIE 2019).*

Lopez, C., Ashour, O., & Tucker, C. S. (2019). "An Introduction to the CLICK approach: Leveraging Virtual Reality to Integrate the Industrial Engineering Curriculum." *American Society for Engineering Education (ASEE).*

Ashour, O., Tucker, C., & Lopez, C. (2020). "Connected Learning and Integrated Course Knowledge (CLICK) Approach." *STEM for all Multiplex.*