The Use & Impact of Virtual Labs in Higher Education

TECHNION
Israel Institute of Technology

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Laboratory Courses in Higher Education

Physical laboratory courses in higher education, also known as “wet lab,” “hands-on lab,” or “in-person lab,” are of great importance for students’ learning processes in STEM fields

Labs give students the opportunity to

- Investigate scientific phenomena
- Have hands-on experience
- Interact with the material world and experience real-word application of theoretical subject matters
- Develop of crucial skills such as
    - Teamwork and collaboration
    - Critical thinking
    - Data collection and analysis
    - Using laboratory equipment and tools

Challenges in Implementing Physical Labs

Despite their importance and contribution for learning, labs pose various challenges for institutions, instructors, and students

LOGISTICS CHALLENGES

- Restricted lab space
- The need for a large amount of equipment and materials
- High maintenance costs
- Staff Salaries

PEDAGOGICAL CHALLENGES

- Assessment methods
- Insufficient experienced instructors
- Time constrains, and safety concerns
- Suitable experiments

What Are Virtual Labs (VLs)

Virtual labs are computer-based simulations or web-based platforms that replicate real-world lab activities to provide students with a simulated hands-on learning experiences. They allow students to practice and experiment with scientific concepts in a safe and controlled environment

Examples include Physics Education Technology (PhET) founded at the University of Colorado or Labster, a commercial educational company that provides virtual labs in Biology, Chemistry and more

Benefits of VLs

- High degree of flexibility interactivity, and safety for learners
- allow students to repeat experiments as many times as they need to in order to fully grasp the concept
- Cost-effective alternative to traditional labs
- Enhance student engagement, motivation, and performance

Types of VLs

1) **Basic VLs:** Multi-question routes leading to a conclusion

2) **Interactive simulations:** Web-based experiments with variable modification and data analysis.

3) **Augmented reality (AR) and virtual reality (VR) VLs:** Interactive learning experiences through virtual objects and environments

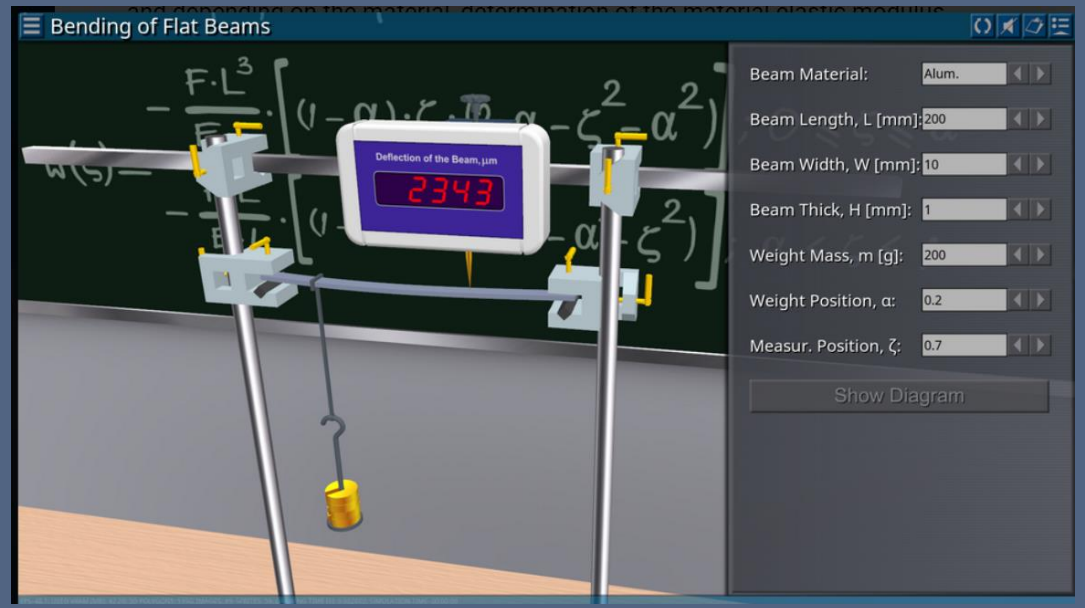
Types of VLs – Examples

Synthesis of Aspirin

Learning Objectives (ILOs)

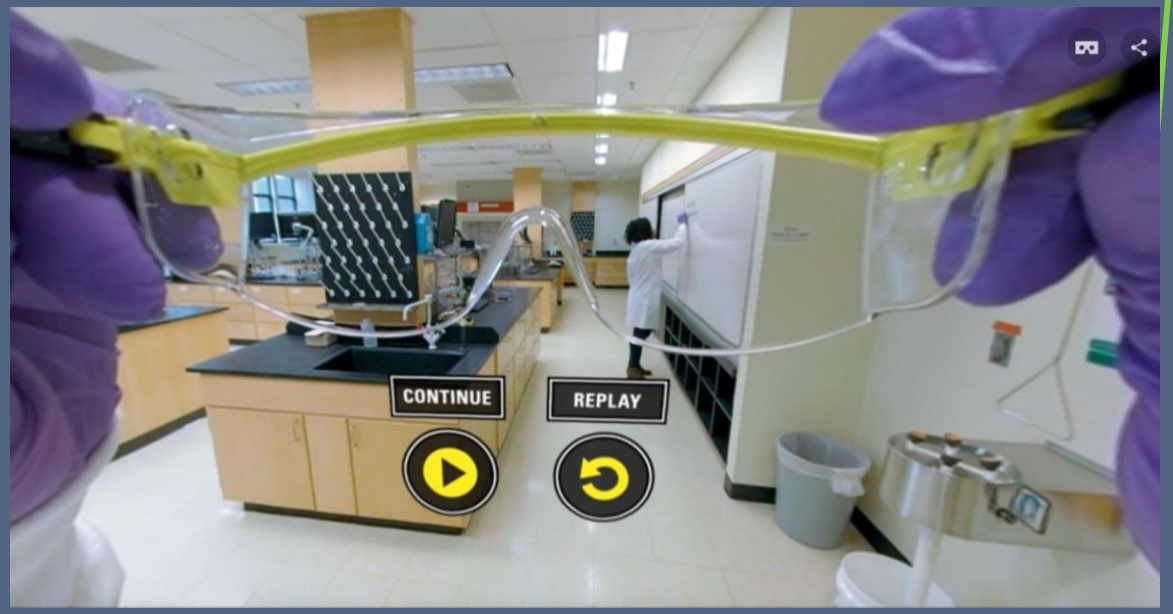
- Become proficient at running organic chemical reactions
- Learning the basics of organic synthesis procedures
- Understand the mechanism of Aspirin synthesis reaction
- Learn the function of Aspirin synthesis reaction
- Get trained on how the setup of the reaction is used

https://praxilabs.com/en/virtual-chemistry-lab



https://sunspire.site/

https://sites.google.com/ncsu.edu/ncstatevrorganicchemistrylabs/home?pli=1



Implementation Strategies

PRE-LAB PRACTICE

Familiarizing students with lab procedures and identifying potential errors

Implementation at the Technion

HOMEWORK

DISCOVERY LEARNING EXERCISES

Exploring scenarios, enhancing understanding, and promoting problem-solving skills

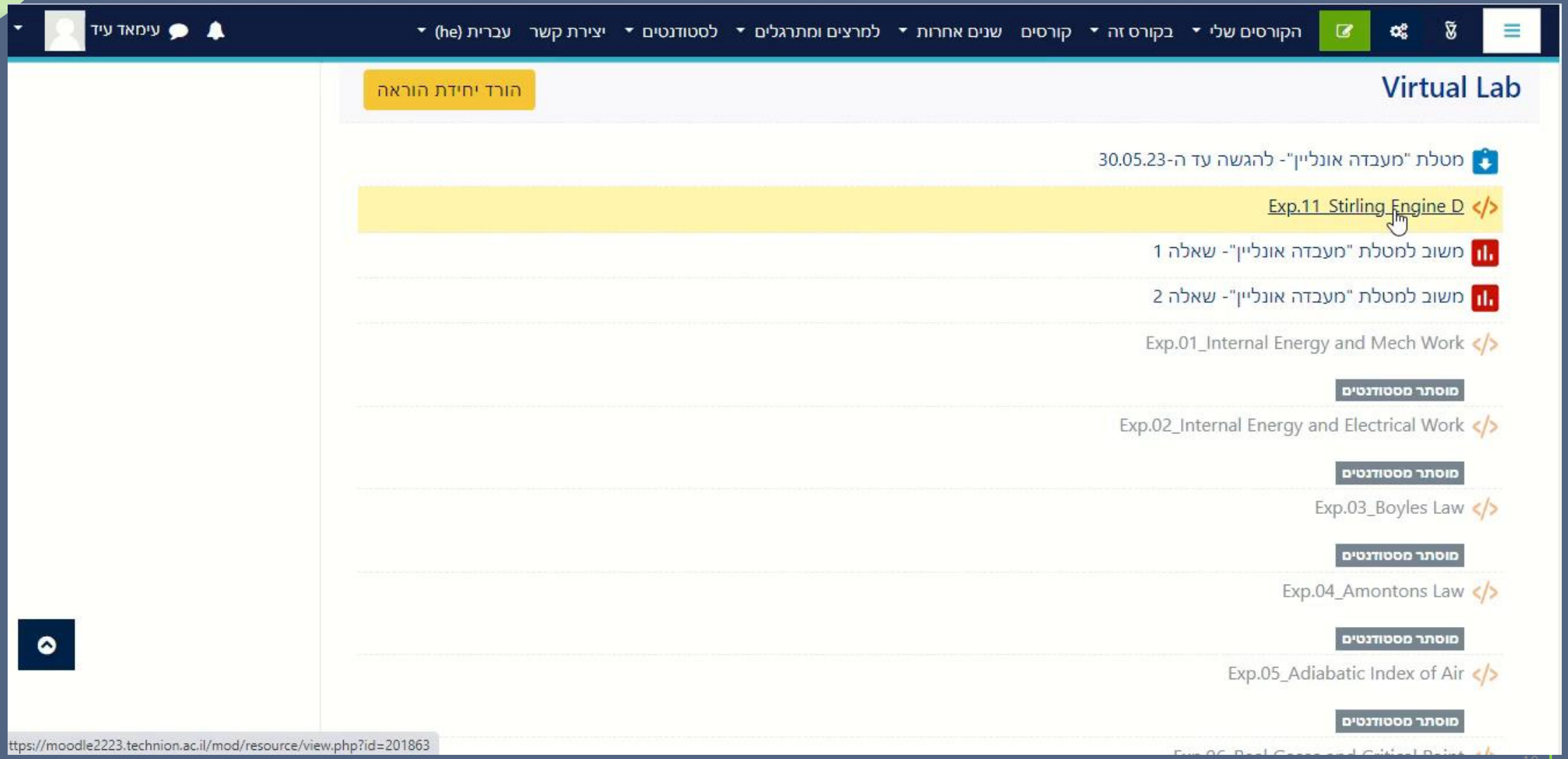
LECTURE-BASED COURSES

Illustrating real-world applications and enhancing visualization skills

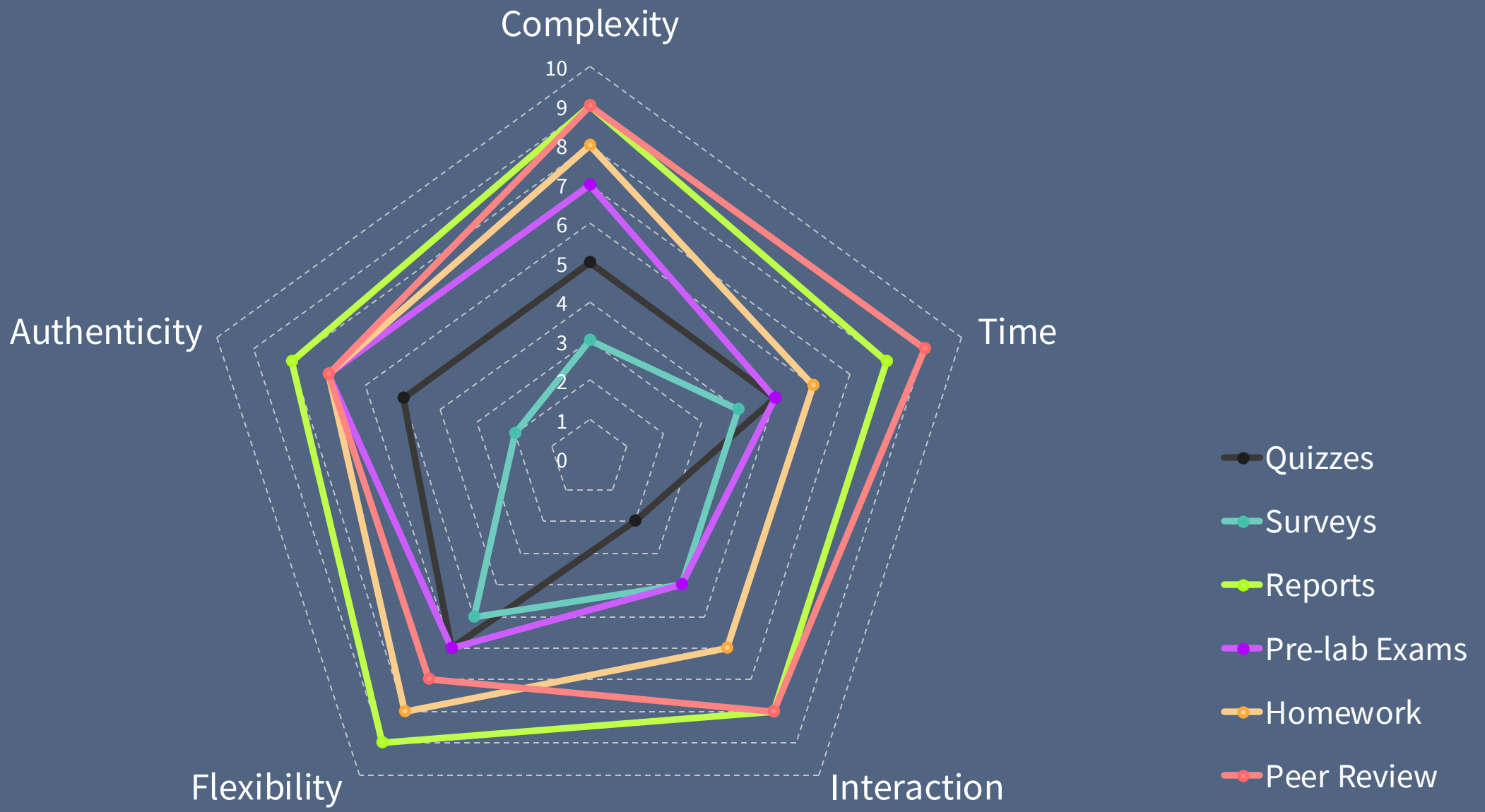
Implementation at the Technion

HOMEWORK, DISCOVERY LEARNING EXERCISES

LECTURE-BASED COURSES



Assessment Methods for VLs



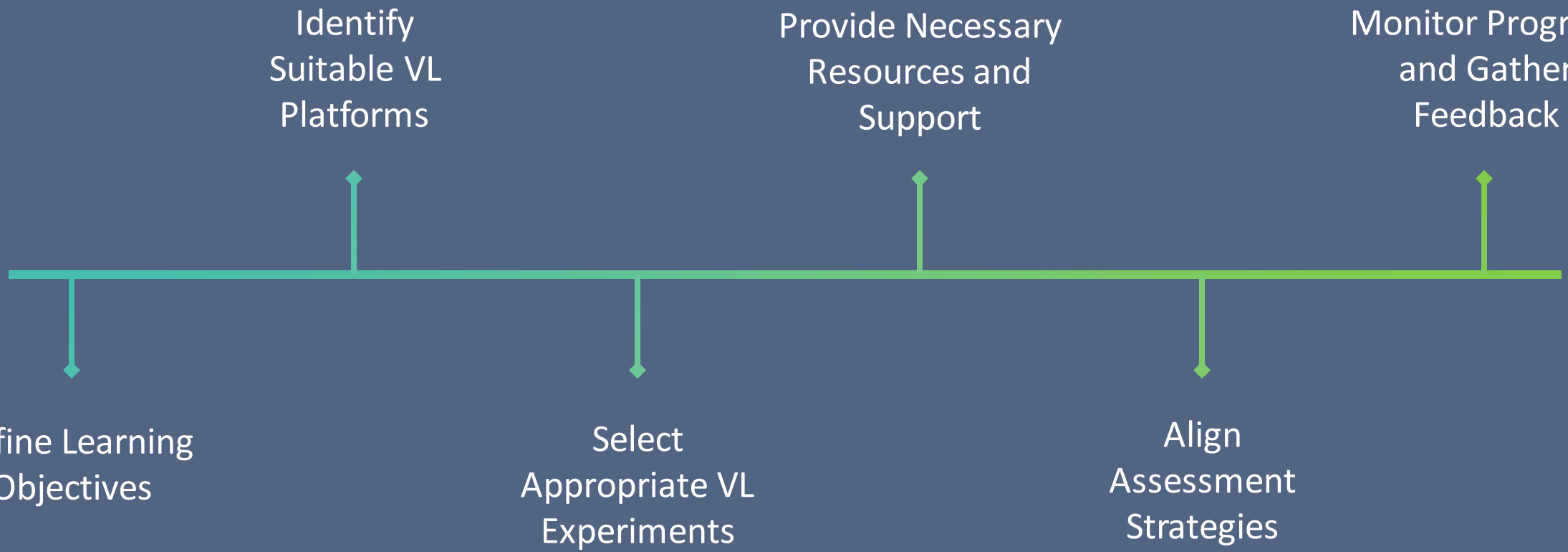
Challenges and Ethical Considerations

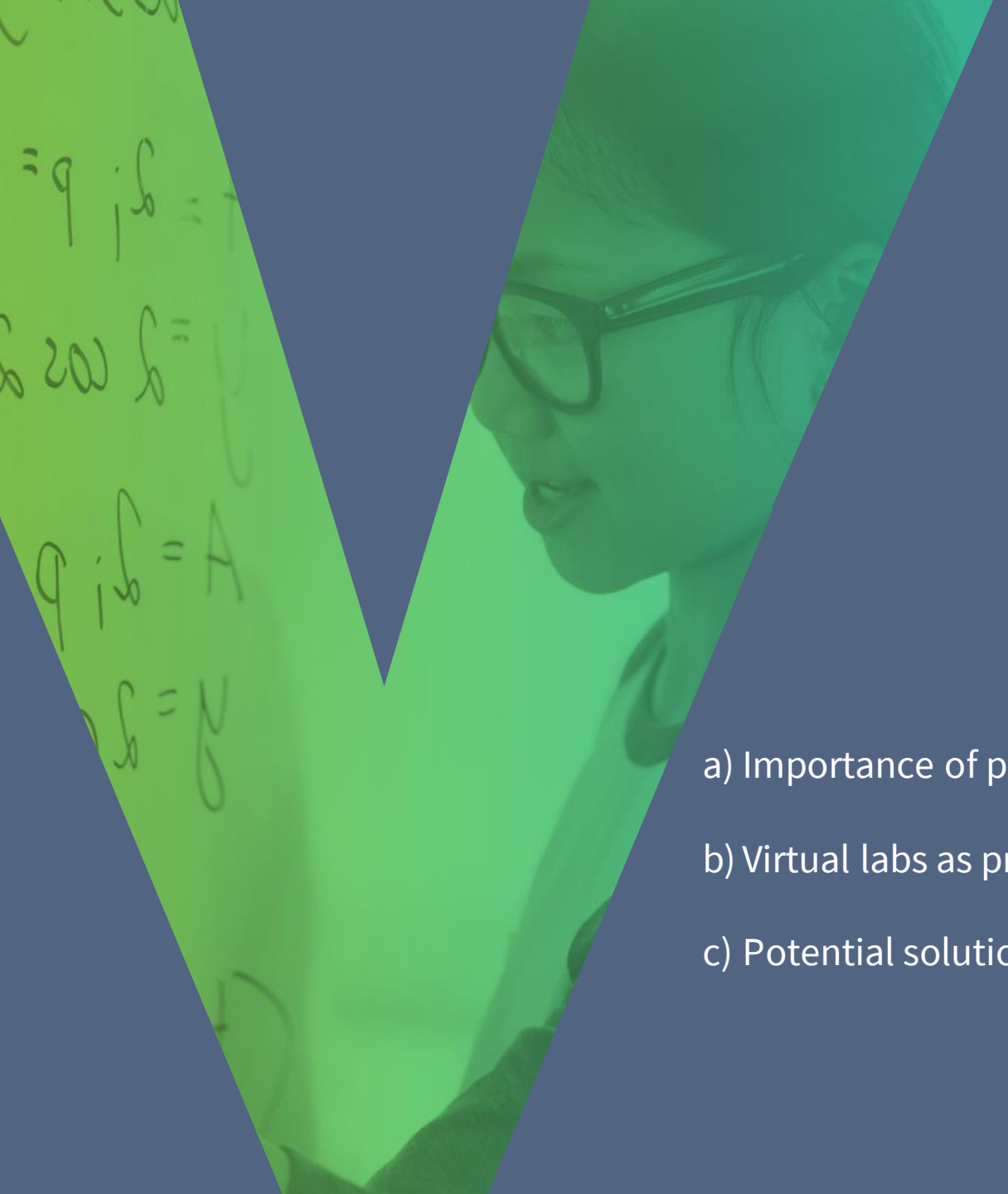
Challenges in finding or creating suitable VLs and keeping them up to date.

Ethical concerns: privacy issues and data collection from students.

Addressing challenges through privacy policies and data anonymization.

Guidelines for Successful Implementation





CONCLUSION

a) Importance of physical lab courses and their challenges.

b) Virtual labs as practical and flexible alternatives with multiple benefits.

c) Potential solutions offered by VLs and their positive impact on STEM education.

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THANK YOU

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Questions?

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