New Perspectives in Science Education

International Conference
NEW PERSPECTIVES in SCIENCE EDUCATION

Experimental evidence of the Problem-Based Learning in Mechanical Engineering Classes and participants' perception

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PUC Minas

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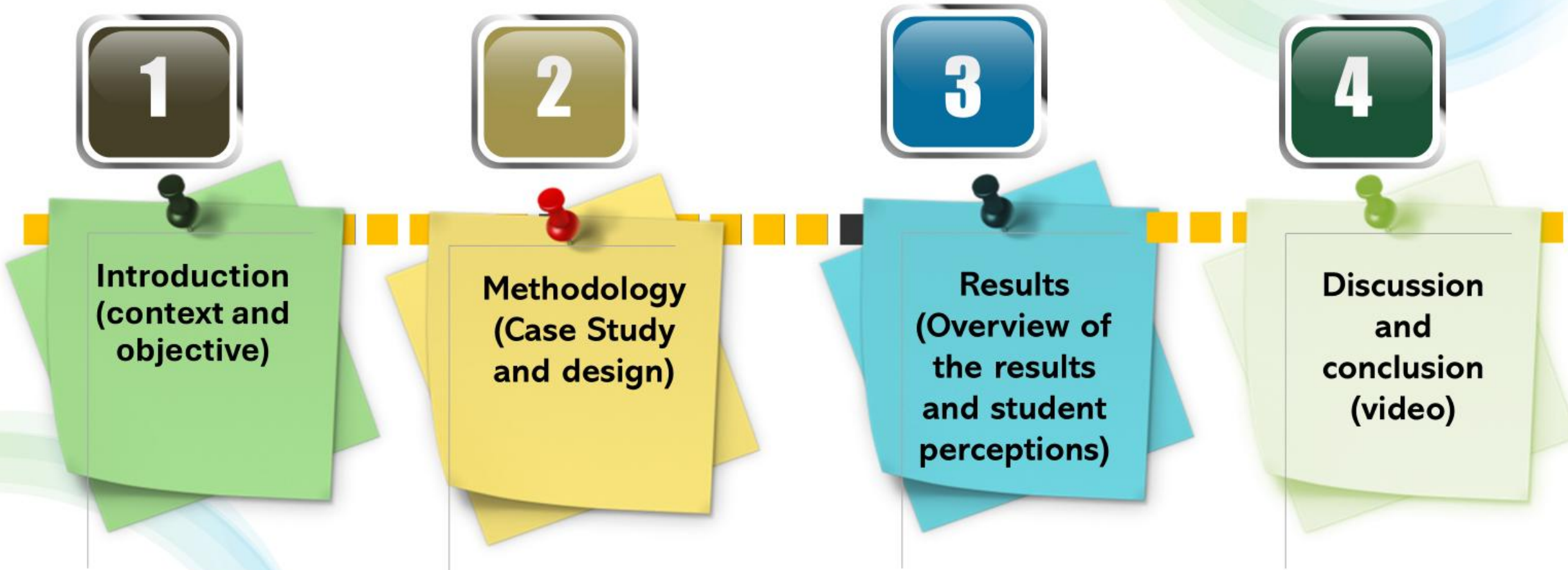
Main points


1
Introduction (context and objective)
2
Methodology (Case Study and design)
3
Results (Overview of the results and student perceptions)
4
Discussion and conclusion (video)

Introduction – Context

High dropout rates in engineering programs stem from math difficulties and passive teaching. This calls for active methodologies that integrate digital tools for enhanced learning experiences.

Exploring Active Learning in Engineering Education

This study investigates **Problem-Based Learning** and the **Flipped Classroom** methodology applied to an interdisciplinary autonomous vehicle project, aiming to enhance student engagement and technical skills.

Key Goals

- Evaluate PBL impact on outcomes
- Measure student perceptions over time
- Develop interdisciplinary practical skills
- Integrate digital learning tools

Exploring Innovative Learning

Experimental Evidence of Problem-Based Learning

- ❖ **Case study of an interdisciplinary project**
- ➢ **Designing and assembling a small autonomous vehicle**
- ✓ **40 teams - Mechanical Engineering at Pontifical Catholic University of Minas Gerais (PUC Minas).**

- **Problem-Based Learning (PBL)**
- **Flipped classroom**
- **Video lessons and gamification**

❑ **Participants' perception, 96 students, Evaluation Committee (CPA) -- Ministry of Education (MEC).**

FLIPPED CLASSROOM

(CLASE INVERTIDA)

WHAT IS IT?

Theory at home → **Práctice in clase**

Inverted pedagogical model

FOUNDATIONS

- Active learning
- Constructivism
- Autonomous learning
- Bergmann & Sams

BEFORE CLASS

- Videos & readings

IN CLASS

- Debates
- Workshops
- Teamwork

AFTER CLASS

- Reflection & Assessment

TEACHER'S ROLE

- Guides & facilitates

STUDENT'S ROLE

Learns & participates

BENEFITS

- More participation
- Classroom time
- Individual attention

CHALLENGES

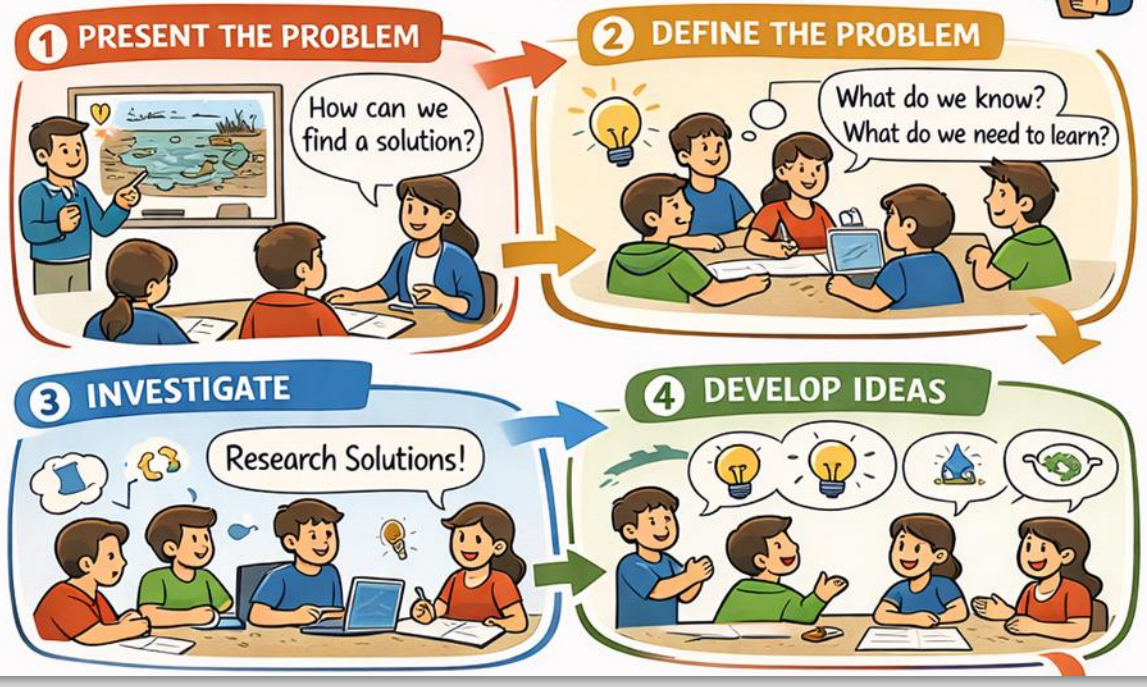
- Lack of preparation
- Digital divide
- Lesson planning

PROBLEM-BASED LEARNING (PBL)

WHAT IS IT?

A student-centered methodology where learning starts with a real-world problem

A REAL-WORLD PROBLEM

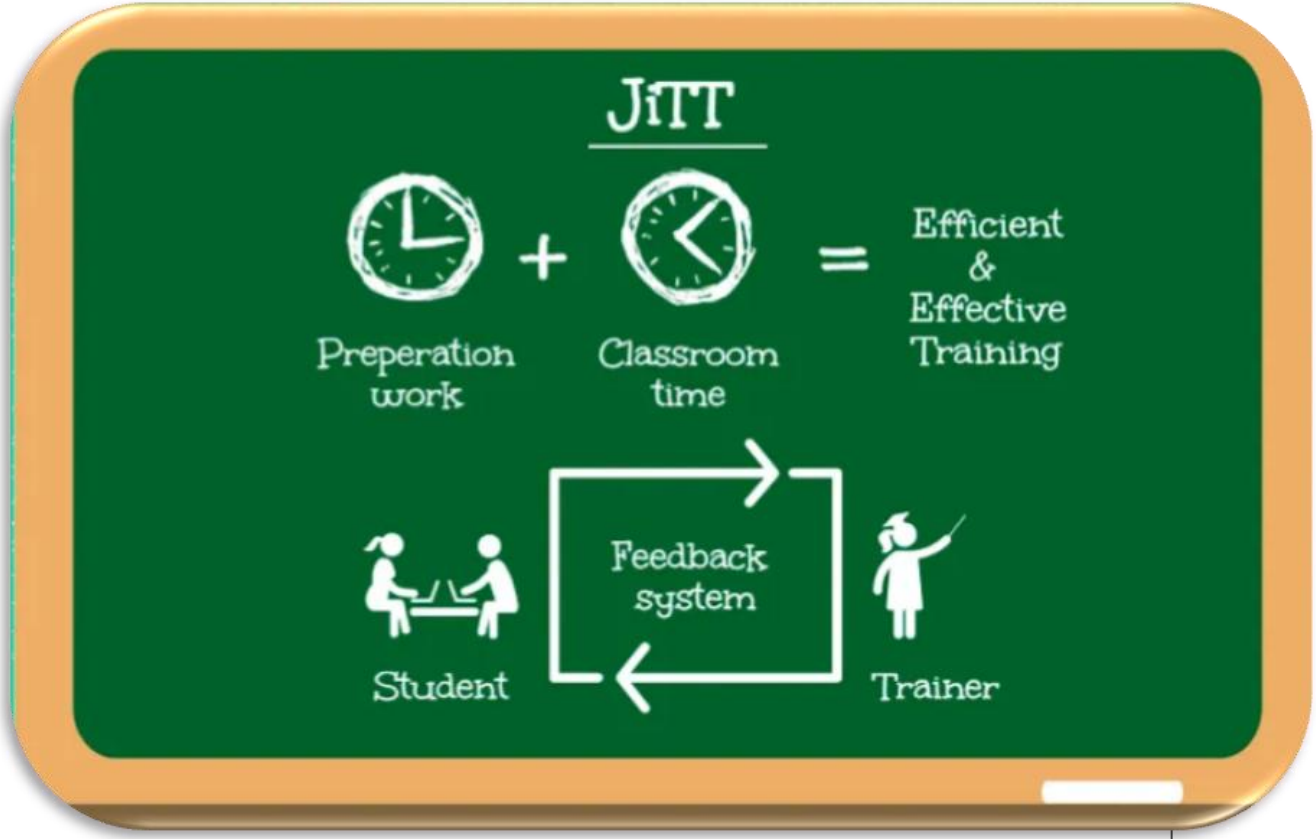


BENEFITS

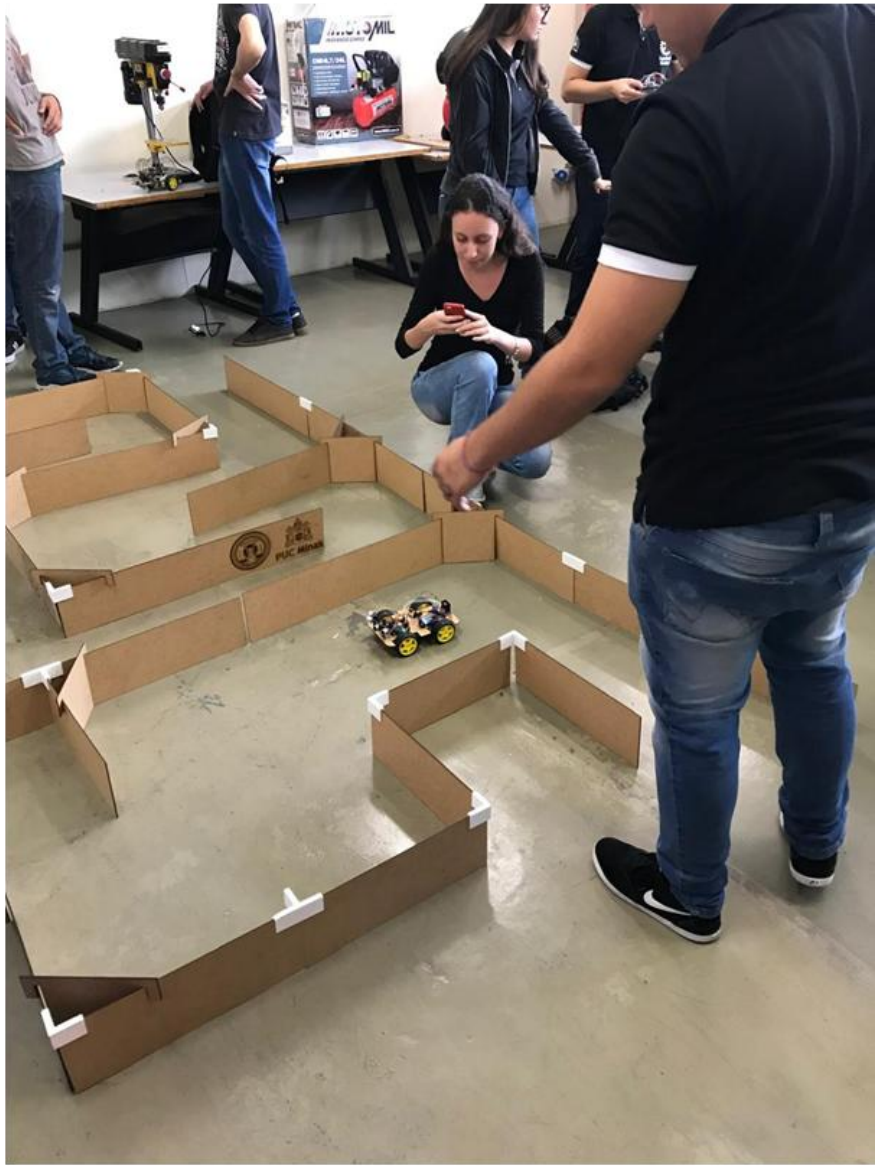
- Foster critical thinking
- Encourage collaboration
- Promote self-directed learning
- Boost engagement

SKILLS DEVELOPED

- Research
- Teamwork
- Problem-solving
- Communication



A method based on **carrying out activities** on a specific topic before it is **discussed in the classroom**, with the aim of **sparking students' interest**.



Active Learning Methods

Exploring innovative educational approaches today

Problem-Based Learning

PBL engages students through real-world problems, fostering collaboration and critical thinking, helping learners develop practical skills while enhancing their understanding of complex concepts.

Just-in-Time Learning

Just-in-Time Learning delivers theory progressively, providing students with the necessary knowledge precisely when they need it, ensuring immediate application in problem-solving contexts.

Flipped Classroom

This approach allows students to learn content outside of class, enabling them to use class time for active engagement and application of knowledge through collaborative activities.

Active Learning

Thinking, discussing, investigating, and creating

Flipped VS Traditional

Flipped

Teacher instructs lesson at home (video / podcast / book/ website)

Students work in class.

- Deeper understanding of concepts, applications, and connections to content are made.
- Students receive support as needed.

Traditional

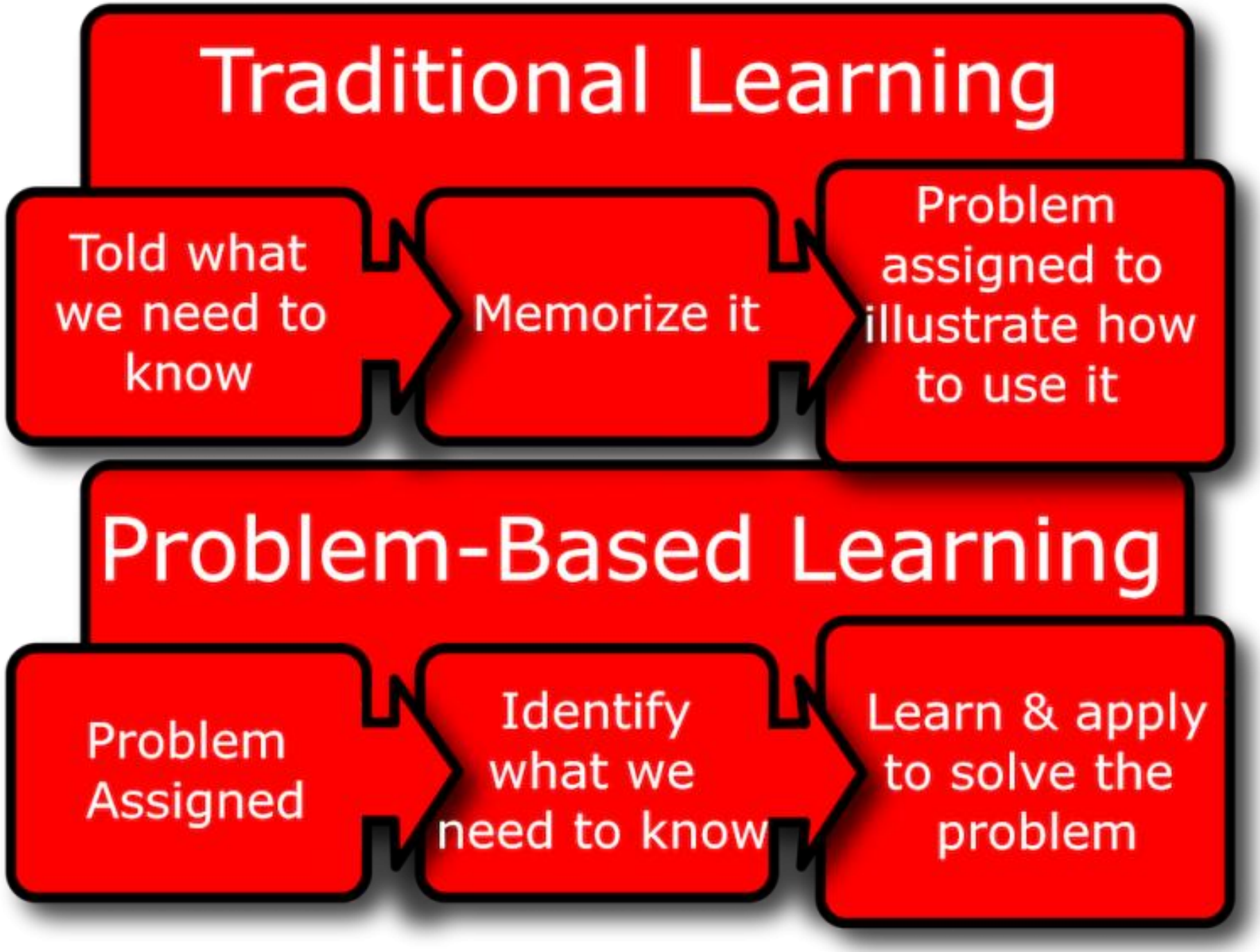
Teacher instructs

Students take notes

Students follow guided instruction

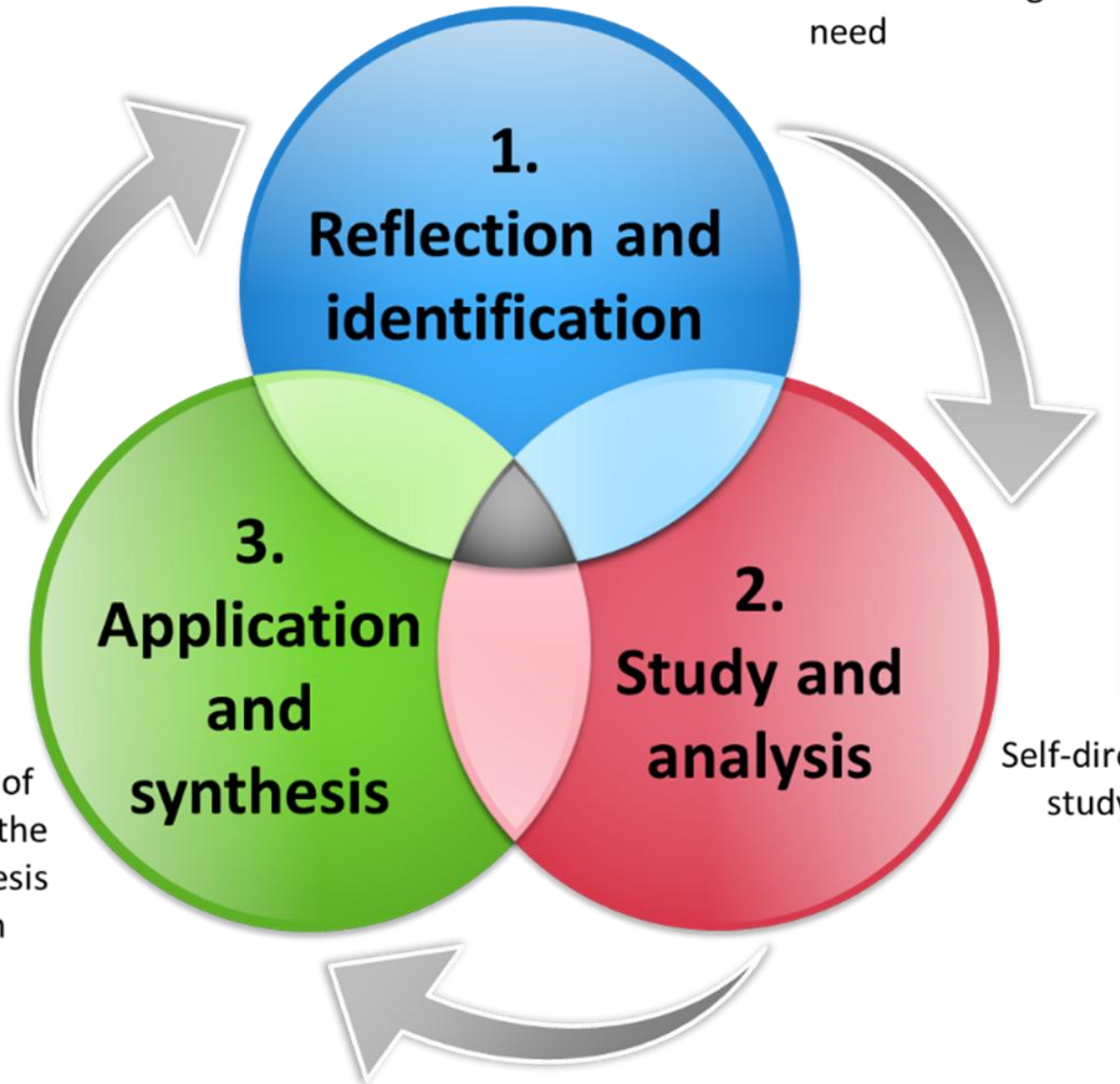
Teacher gives assessment

Students have homework


Traditional Learning
Told what we need to know
Memorize it
Problem assigned to illustrate how to use it
Problem-Based Learning
Problem Assigned
Identify what we need to know
Learn & apply to solve the problem

PLB Cyclical Process

Cooperative reflection on the initial problem and identification of learning need



Self-directed individual study on learning topics.

Group application of new knowledge to the problem and synthesis of what has been learned.

2. Methodology

Methodologies used

Case Study Analysis

The study involves **first semester Mechanical Engineering students**, organized into approximately **40 teams**, tasked with **designing and assembling autonomous vehicles** for a competitive event.

Perception assessment of the 96 students by the University Evaluation Committee (CPA) - Ministry of Education (MEC).

Chassis manufacturing in hackerspace

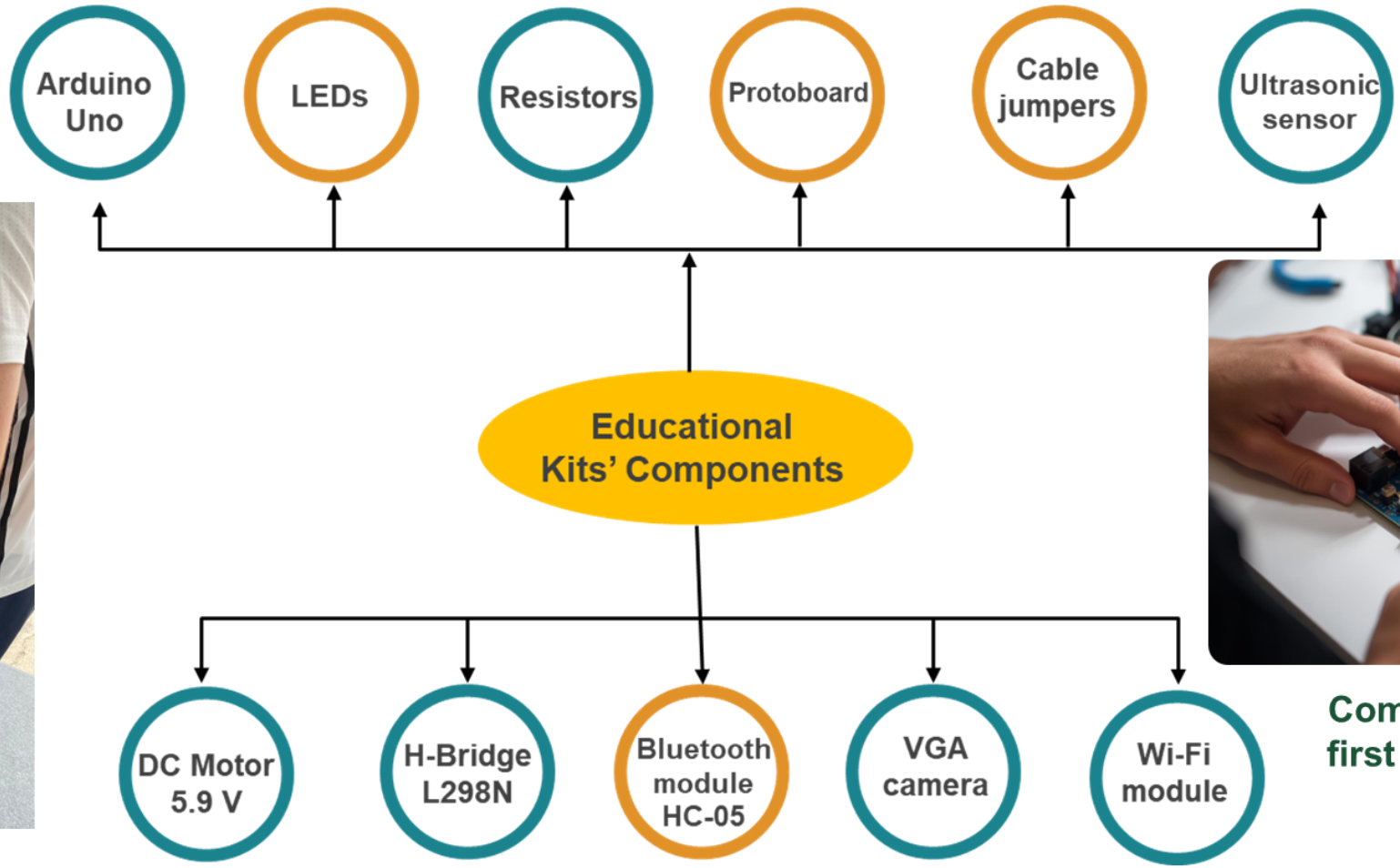
Applied Teaching Methodologies

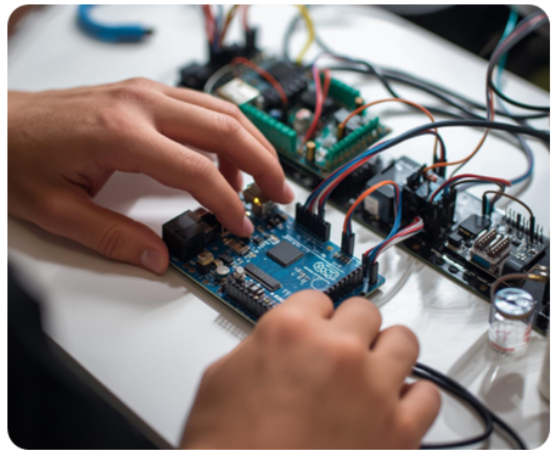
- **Flipped Classroom: Pre-class preparation materials**
- **Active Learning: Engaging in-class problem-solving**
- **Project-Based Learning: Hands-on, real-world projects**
- **Just-in-Time Learning: Theory as needed**

Car assembly in hackerspace

Practical Activities

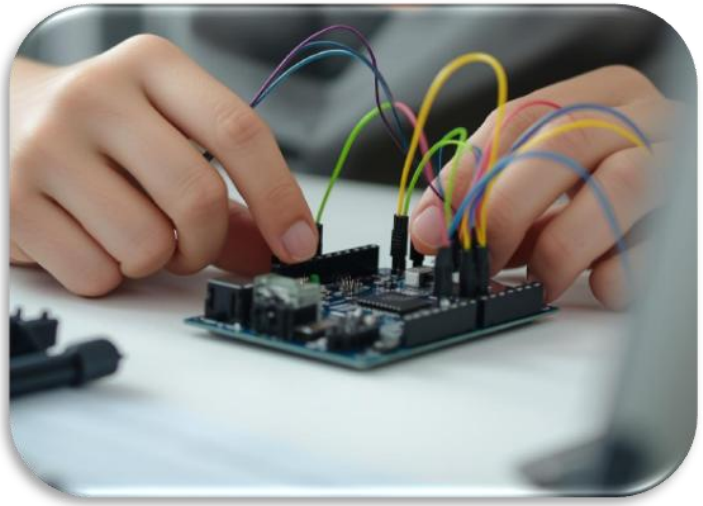
Engaging Students with Hands-On Learning





Components of the first educational kit designed

Students programmed Arduino UNO boards to control sensors, LEDs, and motors, while also designing and fabricating chassis using a laser cutter in the hackerspace environment.



Educational Kits' Components

- Arduino Uno
- H-Bridge L298N
- DC motor shield
- Remote control
- Bluetooth module
- Batteries
- Ultrasonic sensor HC-SR04

Components of the second educational kit designed

The kits include essential **components** for hands-on projects, enhancing students' learning experiences through practical application.

3. RESULTS

Overview of Research Methodology and Data

This exploratory study used diagnostic and quantitative methods over one semester, employing surveys to **assess student perceptions** before and after the implementation of Problem-Based Learning.

3. RESULTS

Student Perceptions

Data illustrate significant improvements in student **motivation**, **engagement**, and **satisfaction** following the implementation of PBL methodologies.

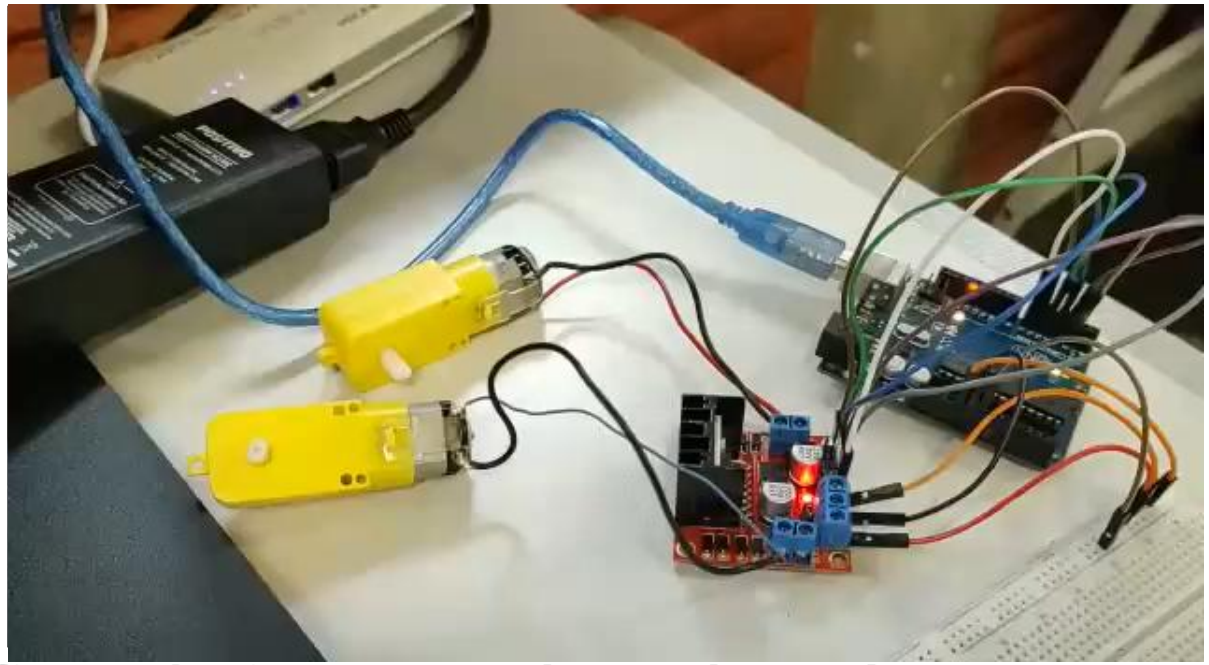
Skills Enhancement

Motivational and Soft Skills Development

The implementation of Problem-Based Learning significantly **increased students' entrepreneurial attitude and autonomy, while improving their teamwork**, leadership, creativity, and conflict resolution skills throughout the project.

Technical Skills

Enhancing Programming and Problem-Solving Abilities

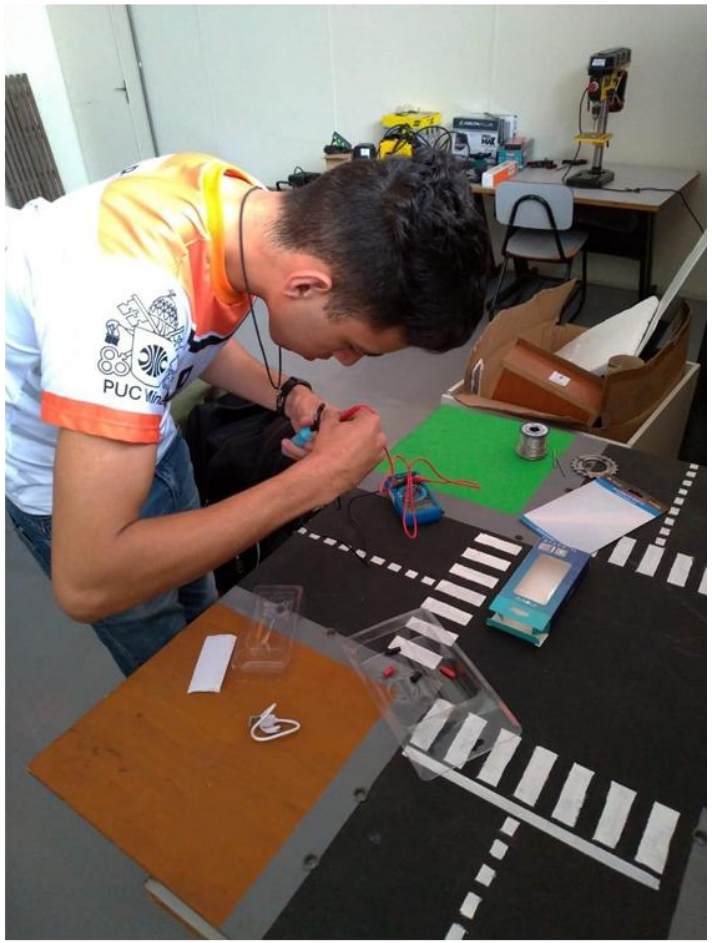


The implementation of PBL significantly improved students' **programming skills** in **Arduino** and **C**, fostering enhanced problem-solving capabilities and increased digital literacy essential for modern engineering.

Student Satisfaction

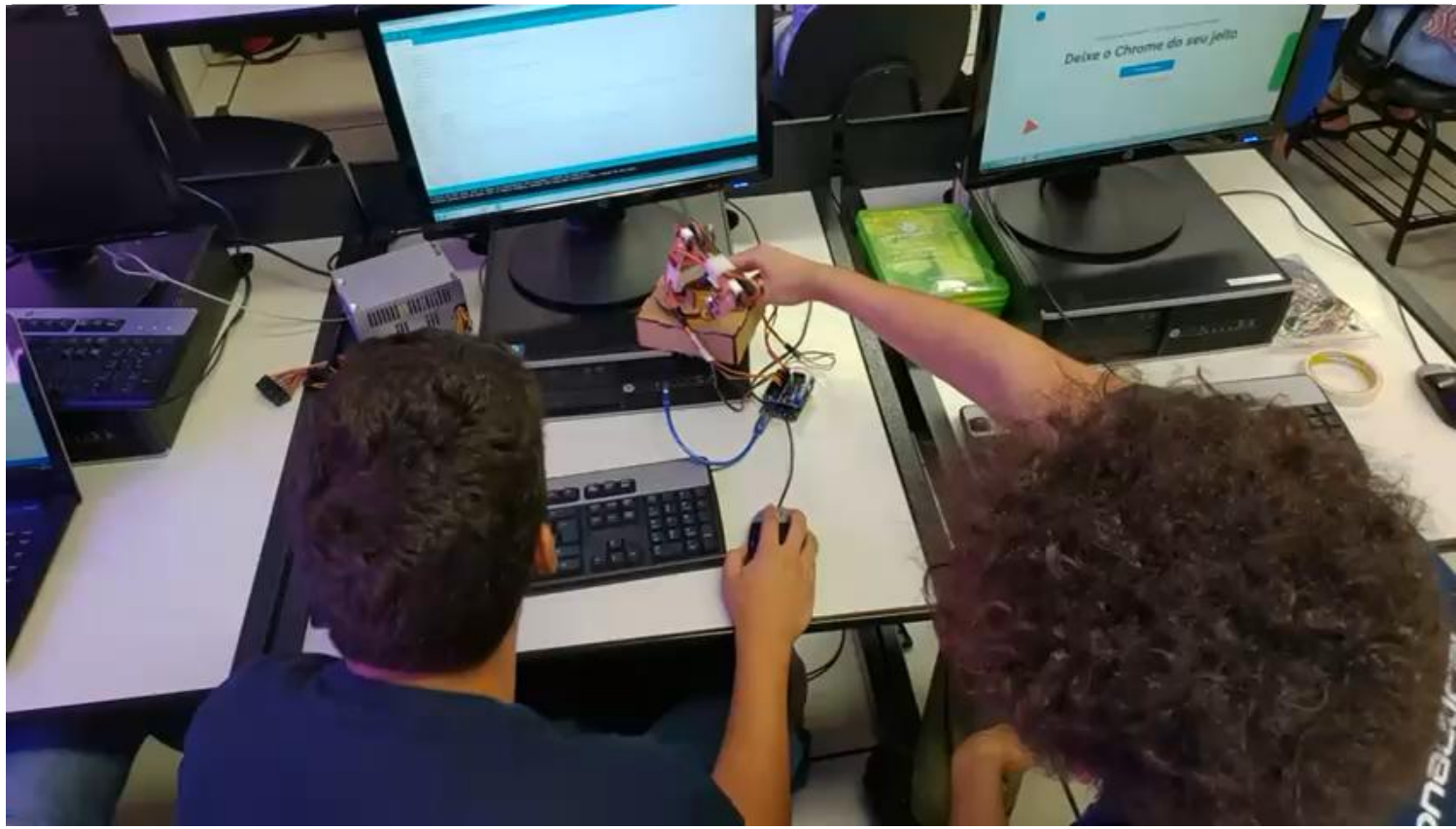
Engagement Through Active Learning Methods

Higher satisfaction scores indicate an effective teaching environment, with **active learning strategies** that foster greater independence and encourage students to take ownership of their educational path.

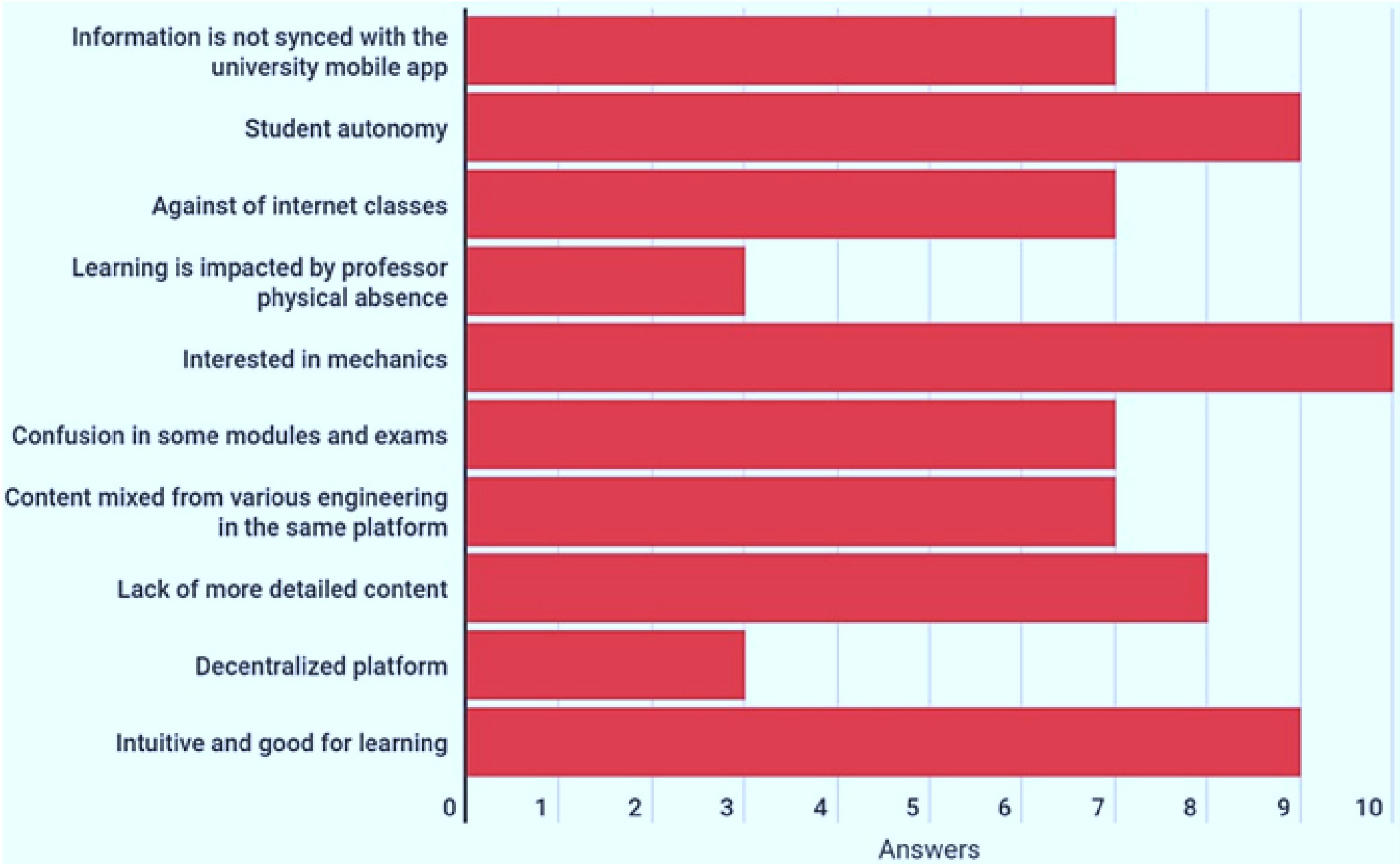


Students in Action

Engaging in hands-on collaboration, **students develop their autonomous vehicle projects**, showcasing teamwork and practical learning experiences.



Results of the student experience



4. DISCUSSION AND CONCLUSION

Problem-Based Learning and Flipped Classroom methodologies significantly enhance student **performance and motivation** while effectively **integrating theory** with **practice** through interdisciplinary projects, fostering deeper engagement in learning.


JUST
DO
IT.
KIT

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