

# Inspiring Students' Interest in Math through ODE Simulation: a Self-Paced, AI-Assisted Approach

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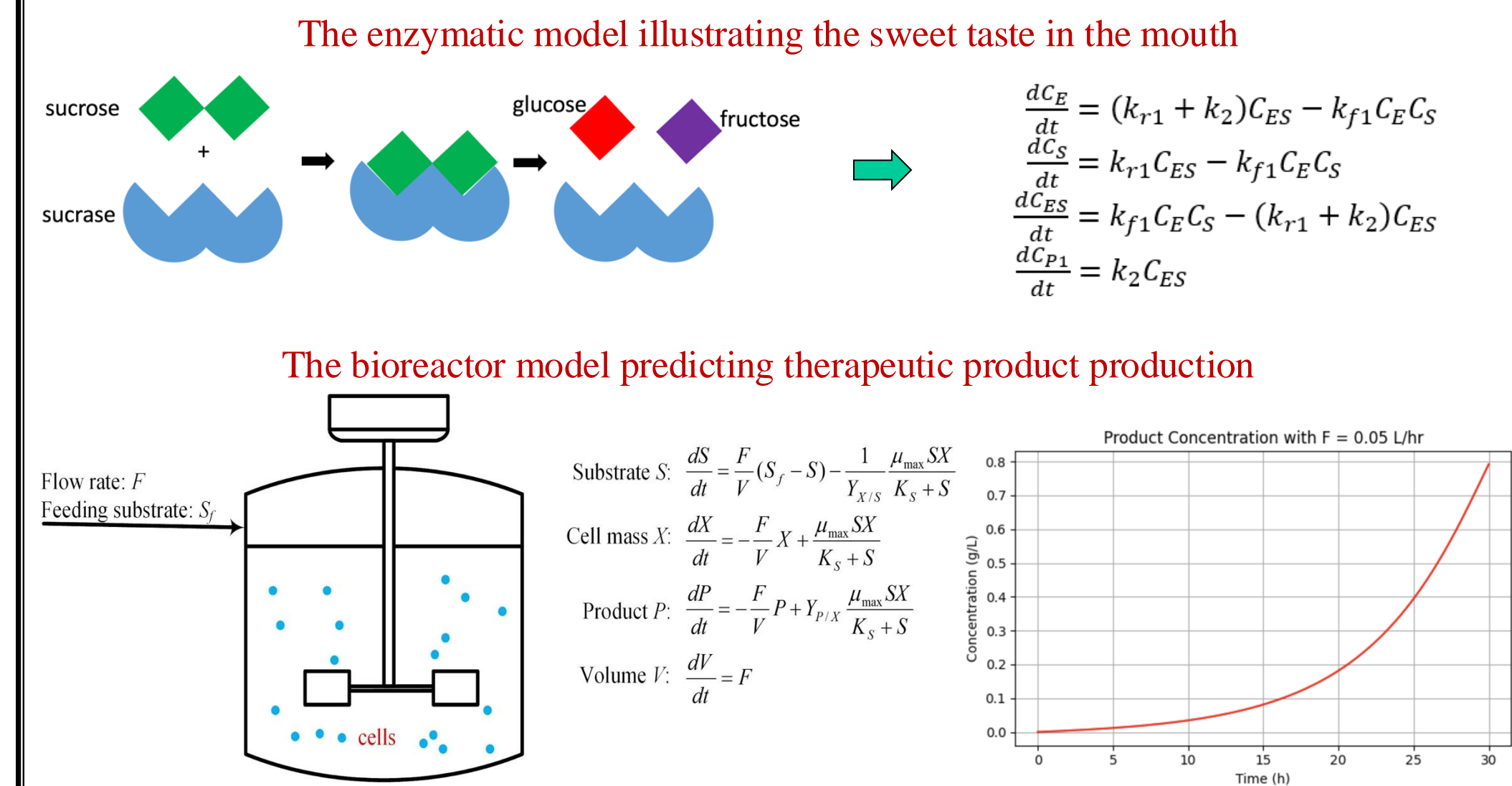


## Background Information & Motivation

- In a study by the Organization for Economic Co-operation and Development (OECD), the mean score in Math tested in The Programme for International Student Assessment (PISA) 2015 for U.S. high-school students' was below the OECD average.
- At the same time, it was mentioned by the President's Council of Advisors on Science and Technology that: "there is a need for the United States to produce approximately 1 million college graduates with STEM backgrounds over the next decade in order to retain its historical preeminence in science and technology".
- Ordinary differential equation (ODE) models can effectively represent biological processes related to students' everyday experiences and offer them the opportunities for making real-world predictions [1-5].
- Artificial intelligence tools, such as ChatGPT, offers a novel approach to improve students' understanding of ODE modeling, ignite students' interest in math through practical and relatable applications, better equip students for college-level studies.
- This project introduces an AI-assisted approach to teaching ODE modeling, which was tested by high school students with the potential to be applied to college students, while evaluating their performance and gathering feedback on their AI-based learning experience.

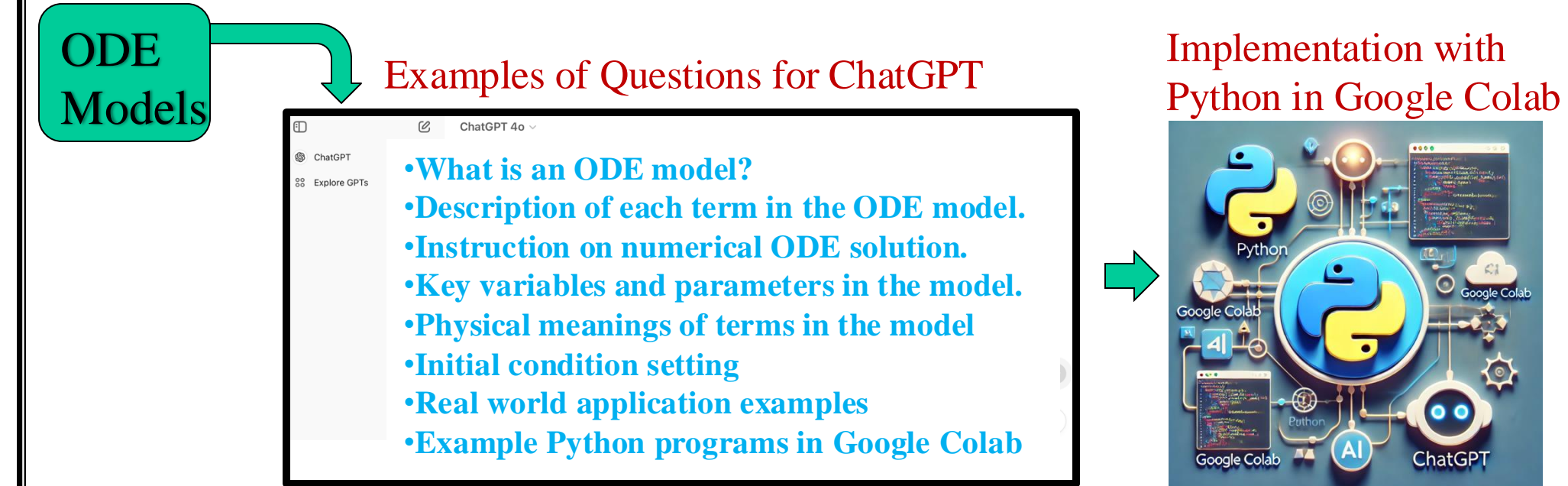
## Introduction of ODE Models

- ODE models for the car distance model, the classical enzymatic model, and the fed-batch bioreactor model were given to students.



## The Application of ChatGPT in Guiding Student Learning

- ChatGPT was used to to understand each term in the ODE models, numerical solutions used to solve ODE models.
- Students learned to simulate the three ODE models in Google Colab by using ChatGPT to learn Python coding – the most population programming platform in AI.
- Students then applied their models to open-ended, real-world scenarios chosen by them.



## The Project Implementation

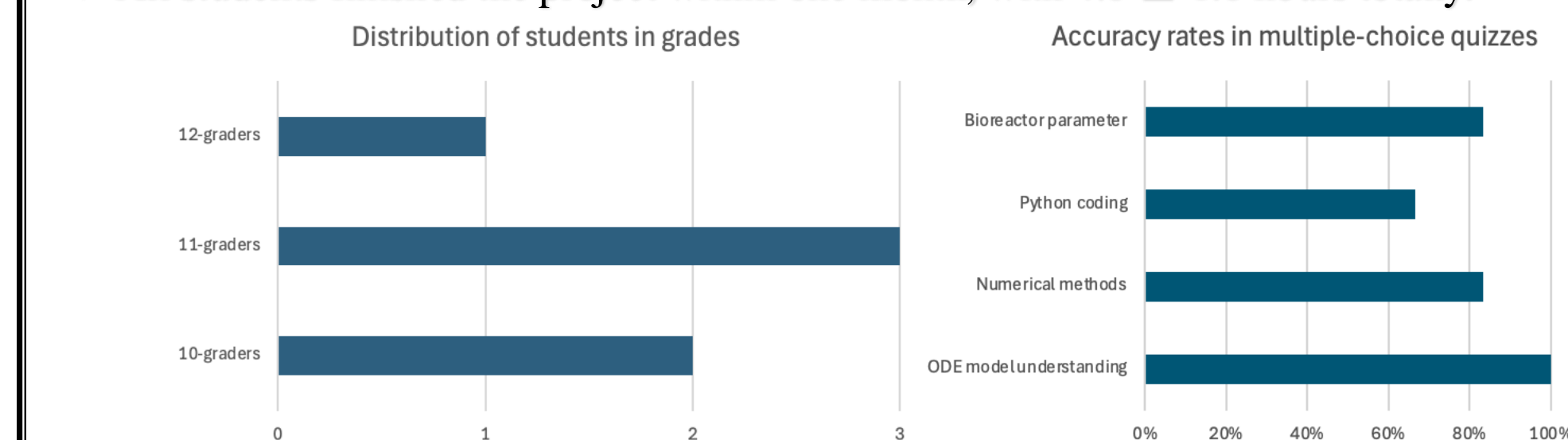
- This is totally self-paced project, but a guide document was given to students with the following information:
  - The equations with initial conditions and parameter values for each of the three ODE models
  - Example questions for ChatGPT on each ODE model
  - Example questions for ChatGPT on learning basic Python programming
  - Example questions for ChatGPT on implementing ODE models with Python in Google Colab.
- Students were asked to submit the following materials after they finished the project:
  - Record their understanding of each ODE model in a WORD document.
  - Record their simulation results of each ODE model in the WORD document.
  - Provide their Python program for each ODE model in Google Colab.

## Evaluation of Student Learning

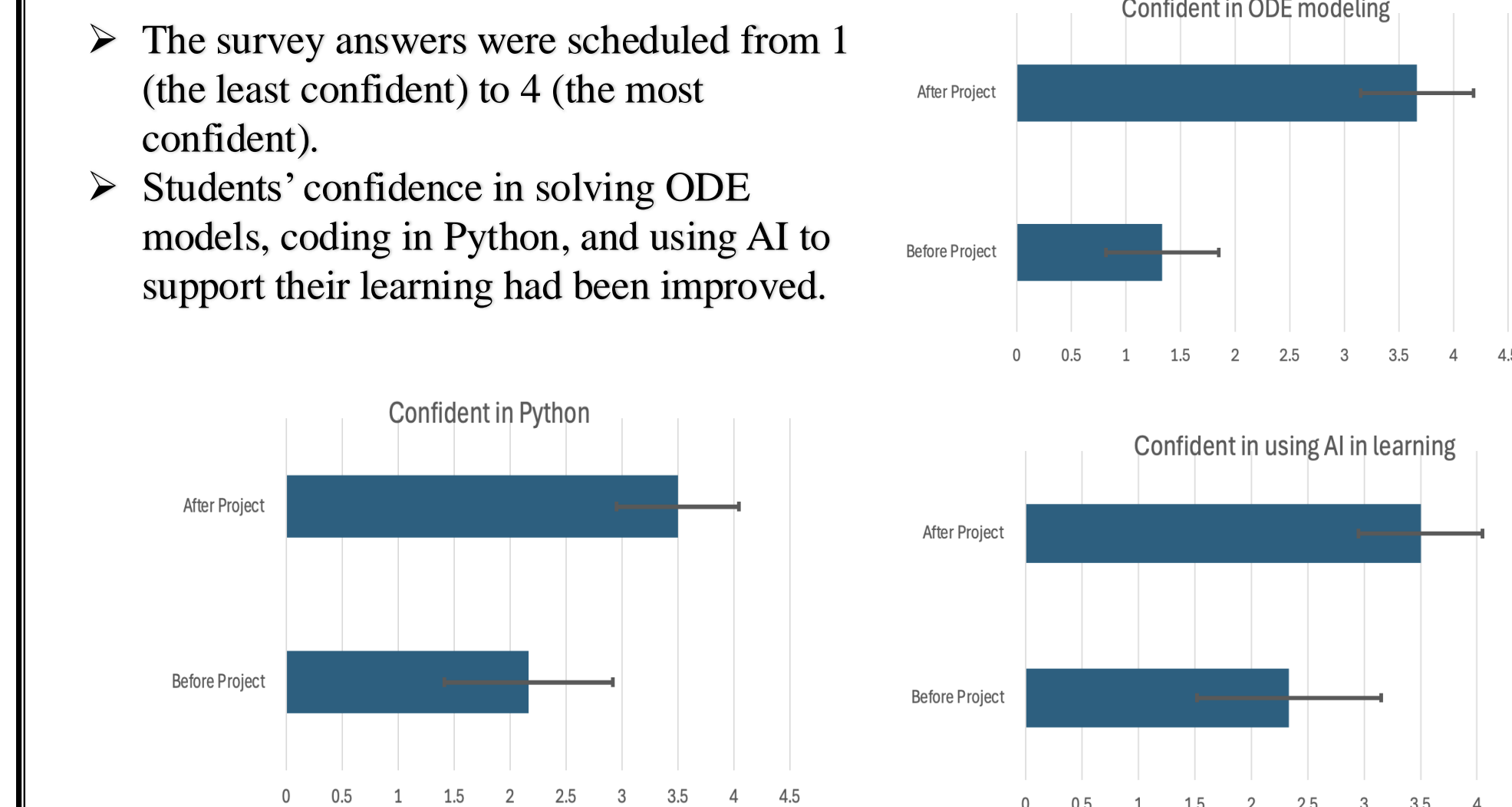
- Direct evaluation by the instructor: (1) students' understanding of ODE models, (2) students' programs and simulation results, and (3) multiple-choice quiz about the ODE modeling and Python coding.
- Students' anonymous survey that includes four sections:
  - Section 1 was used to college students' demographic information.
  - Section 2 was designed to evaluate the improvement of students' skill in: (1) understanding ODE models, (2) solving ODE models with Python in Google Colab; and (3) using AI to solve problems.
  - Section 3 was used to evaluate students' AI-based learning experience and whether this project inspire students' interest in STEM.
  - Section 4 was designed for getting students' opinions on what they like or dislike this project.

## Evaluation of Students' Improvement in Modeling and Coding Skills after the Project

- Evaluations of students' modeling and programming skill by multiple-choice quiz designed by the instructor:
  - All high-school students were able to develop the ODE model in Python by themselves.
  - All students finished the project within one month, with  $4.8 \pm 1.8$  hours totally.

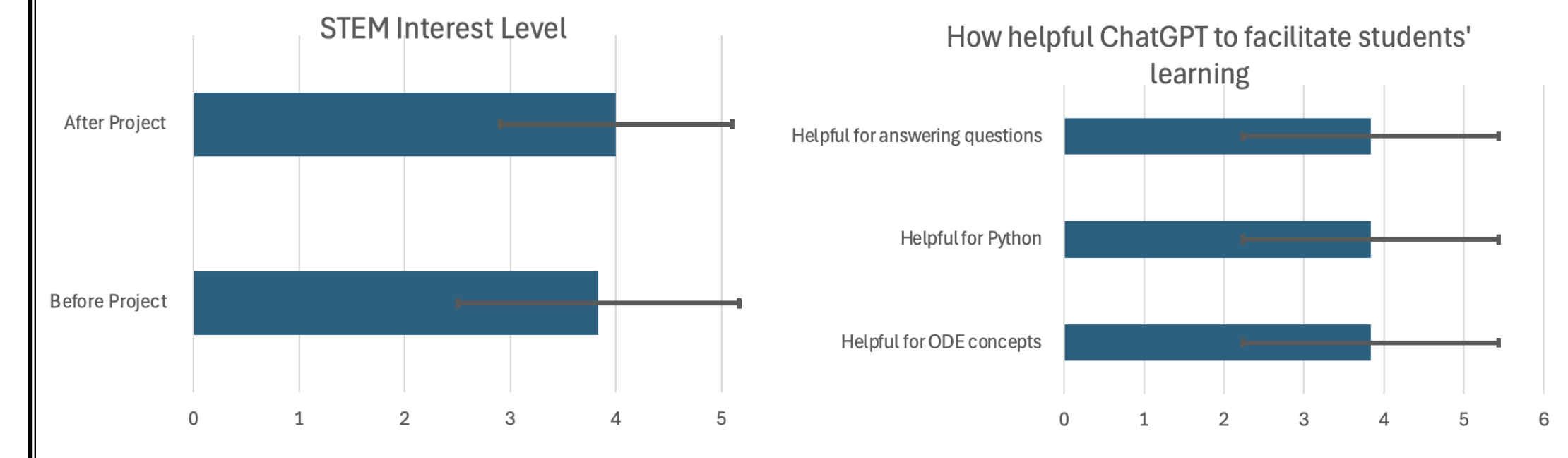


- Students' self-evaluation of their skills in solving ODE models in Python after the project



## Survey Results on Evaluating Students' Learning Experience in this AI-Based Self-Paced ODE Modeling Project

- Students' interest in STEM was slightly improved from 3.8 to 4.
- Students generally agreed that ChatGPT is helpful in facilitating their learning



## Survey Results on the Open-Ending Questions for Students' Comments on this AI-Based Self-Paced ODE Modeling Project

- Enjoyable Aspects: "Success in coding and seeing results."
- Challenges:
  - "Starting ODE models with little instruction."
  - "Altering AI-generated code."
  - "Deciphering symbols in ODE models."
- Suggested Improvement for the project:
  - "More specific AI-guided instructions."
  - "More ODE problems to practice."
  - "Clarify enzyme/bioreactor parameters."

## Conclusion

- In this project, high school students with minimal prior exposure to ODEs successfully developed and simulated models using ChatGPT.
- The project allowed students to work independently, with ChatGPT providing timely support for problem-solving and model simulation.
- Students showed confidence in understanding ODEs, Python coding, and using AI tools, despite some challenges with modifying AI-generated code and understanding unfamiliar terminology.
- Feedback highlighted areas for improvement, including the need for clearer AI-guided instructions and more practice with diverse ODE models.
- The pilot project's success suggests AI-driven learning can effectively supplement traditional teaching methods.
- This project will be improved and implemented in college-level process control course.

## Reference

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