

Transforming Freshman Education: AI-Driven Self-Learning in SAT006 Computer Science and Engineering

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1. Background

SAT006 is a large-scale introductory computer science and engineering module at XJTLU with 710 first-year students. The computing component emphasizes self-directed Python programming learning through BlockPy and tutorial handbooks. However, with only seven instructors and teaching assistants, the staff-to-student ratio is less than 1%, making it impossible to provide timely support for every student. Learners often struggle with syntax errors, conceptual misunderstandings, and difficulties in programming logic. To address these challenges and reduce the support gap, XIPU AI was introduced as a non-human teaching assistant to enhance self-learning efficiency and improve students' learning experience.

2. Solutions

In this case study, a controlled experiment was conducted in SAT006. Students were randomly divided into baseline and experimental groups. The baseline group followed the standard learning procedure, while the experimental group had access to XIPU AI and was encouraged to consult AI before approaching teaching staff. Solutions included:

1. **Integrating XIPU AI into the Learning Mall course page:** Students could open the AI assistant directly from the module homepage and input code snippets, error messages, or questions.
2. **Providing instant feedback and explanations:** XIPU AI offered syntax error detection, logic clarification, programming concept explanations, and personalized code analysis.
3. **Supporting self-directed learning workflows:** When encountering difficulties, students could first obtain AI-generated guidance, then deepen understanding through follow-up interactions with instructors.
4. **Assisting with debugging and code generation:** XIPU AI helped beginners identify the causes of errors, quickly generate example code, and provide conceptual guidance.
5. **Scaling to large cohorts:** By automating responses to repetitive questions, XIPU AI reduced staff workload and allowed instructors to focus on more advanced and individualized student support.

3. Outcomes and Benefits

A total of 273 students completed all questionnaires, with 165 using XIPU AI. Key outcomes include:

- Improved course satisfaction: Higher average ratings in the AI group (5.45 vs. 5.12).
- More useful assistance: Students reported more effective support (5.42 vs. 5.19).
- Higher self-learning effectiveness: AI users rated their learning processes more effective (5.44 vs. 5.19).
- More personalized feedback: AI group perceived feedback as more personalized (5.35 vs. 5.04).
- More interaction with teaching staff: AI helped clarify preliminary problems, enabling more meaningful teacher-student interactions.

Interviews revealed that students appreciated AI's fast error detection, immediate solutions, beginner guidance, and pressure-free interaction.

Limitations include difficulty understanding poorly phrased questions, less contextual depth than human teachers, and general mistrust toward AI.

4. Replicability and Promotion Value

This case demonstrates strong replicability and can be applied across various departments, programming courses, and self-directed learning environments. Since XIPU AI integrates seamlessly without requiring major changes to existing course structures, it is particularly effective in large-scale classes with limited teaching resources. Beyond Python, the approach can be extended to other programming languages such as C++ and Java, especially in lab-based or introductory courses where repetitive questions and high demand for assistance are common. Therefore, the case holds substantial potential for broader adoption.

5. Next Steps

Future efforts will focus on improving XIPU AI's ability to interpret student queries, enabling more accurate and context-aware responses. The teaching team also plans to develop structured guidelines to help students use AI more effectively and refine their self-learning strategies. Additionally, a collaborative "AI + instructor" teaching model will be explored, where AI handles foundational explanations and preliminary troubleshooting while instructors address more complex issues. Further exploration will include expanding AI support to additional platforms such as BlockPy and Tinkercad to enhance the self-directed learning experience.