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"Slacking" or "Empowering"? The Dual Impact of AI Programming Assistants on the Development of College Students' Computational Thinking

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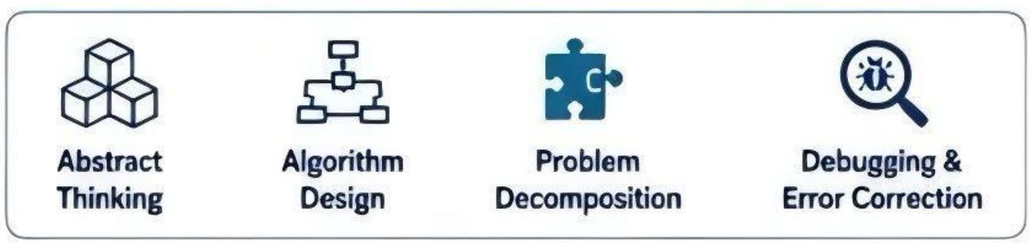
1 INTRODUCTION & AIM

Generative AI programming assistants are rapidly integrating into STEM programming classrooms. Yet, whether they enhance or weaken college students' computational thinking (CT) remains unclear.

This study explores the dual impact of AI programming assistants on CT in four dimensions: abstract thinking, algorithm design, problem decomposition, and debugging & error correction.

We aim to reveal the dual value and boundary conditions of AI tools in university programming education and propose teaching strategies that balance efficiency and thinking cultivation.



2 METHOD

Research Design → Quasi-experimental study with one-month intervention

AI-Assisted Learning Group (Experimental)

- Use AI programming assistants (e.g., Copilot, ChatGPT) in learning
- Guided prompts & reflection
- Teacher scaffolding

VS.

Traditional Teaching Group (Control)

- Traditional programming teaching
- No access to AI assistants
- Same content & tasks

Participants Undergraduate students from different universities (N ≈ 120, two intact classes)

Data Collection

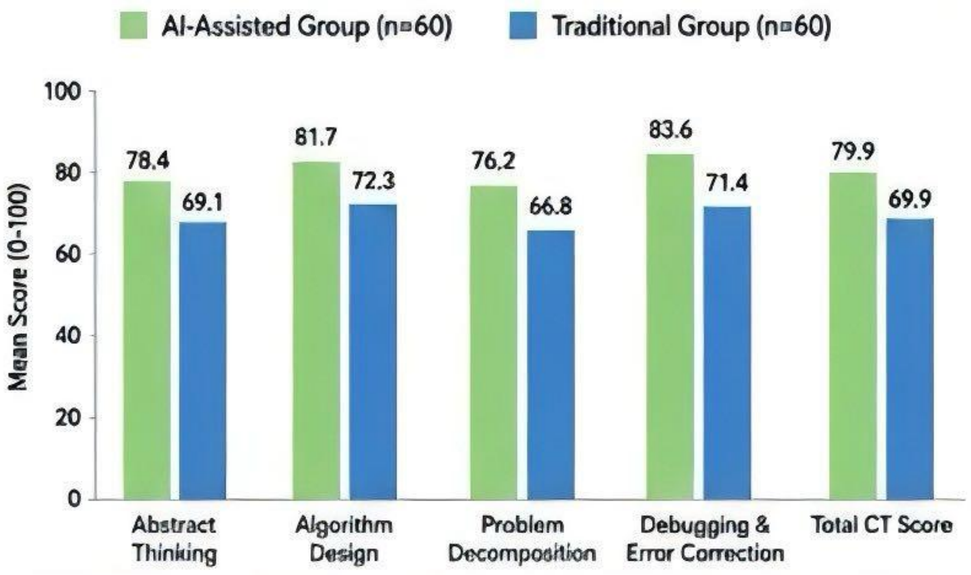
- Computational Thinking Scale
- Programming Work Analysis
- Classroom Observation
- Semi-structured Interviews

Intervention Process (4 weeks)

1. Pre-test (CT Scale)
2. Teaching Intervention (4 weeks)
3. Post-test (CT Scale)
4. Data Analysis & Interviews

3 RESULTS & DISCUSSION

Quantitative Results (Post-test)



The AI-assisted group outperformed the control group in all dimensions and overall CT score ($p < .05$). The largest gains were in algorithm design and debugging.

Qualitative Findings

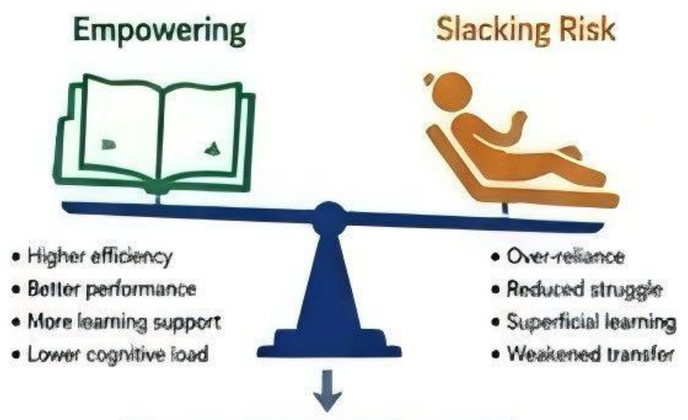
Abstract Thinking AI tools help students quickly obtain ideas and code patterns, promoting abstraction. However, over-reliance may weaken independent abstraction ability.

Algorithm Design AI provides efficient algorithmic references, improving learning efficiency. But some students accept suggestions blindly without deep understanding.

Problem Decomposition AI assistance supports multi-step analysis, but students still need teacher guidance to develop their own decomposition strategies.

Debugging & Error Correction AI significantly improves debugging efficiency and error location ability, yet some students reduce their own effort in identifying root causes.

Discussion: Dual Impact



Boundary Conditions

- Task complexity
- Quality of AI interaction
- Teacher scaffolding
- Student self-regulation

AI programming assistants can empower CT development, but may also cause "slacking" when used improperly. The key lies in how, when, and for what purpose students use AI tools.

4 CONCLUSION

- AI programming assistants have a significant positive impact on college students' computational thinking, especially in algorithm design and debugging.
- However, they also carry the risk of "slacking", such as over-reliance and shallow learning.
- Balanced integration with appropriate scaffolding and regulation is essential to maximize the empowering value of AI in programming education.
- This study provides empirical evidence for the high-quality development of STEM education under technology empowerment.

5 FUTURE WORK / REFERENCES

Future Work

- Conduct long-term follow-up studies on CT development.
- Explore the impact of different types of AI tools and usage strategies.
- Investigate the role of self-regulation and motivation in AI-assisted learning.
- Expand samples to multiple disciplines and institutions.

References (Selected)

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