Supporting conceptual and cognitive progression: Integrating flipped design and peer instruction into an upper-secondary physics tutorial model

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Rationale and objective: In many Thai upper-secondary physics classrooms, teaching is dominated by lectures, formula memorization, and drills on past exam papers, driven by the pressure of university entrance examinations. This leaves little room for exploring concepts, and students with weaker foundations often struggle to keep up. Active learning methods such as peer instruction, and flipped classrooms have each shown benefits, but mostly with university students. This study aimed to develop and test a tutorial teaching model that combines elements of these approaches for Grade 12 physics.

Summary: The model has three phases. Before class, students learn basic ideas from online materials and recorded video lessons. In class, the teacher gives a short review and demonstration, then poses a conceptual problem. Students think individually, discuss in small groups, and work through a three-step worksheet (interpret the situation, identify the variables, apply the equations), guided by the teacher's questioning rather than direct answers. Some topics also included hands-on mini-laboratories. After class, students review their worksheets and recorded lessons. The model was used for one semester with 149 students at two schools in Bangkok, covering solid deformation, thermal processes, and fluid mechanics. Learning was assessed with pre- and post-tests, analysis of student work using the SOLO taxonomy (which classifies the depth of reasoning), and interviews with 34 students.

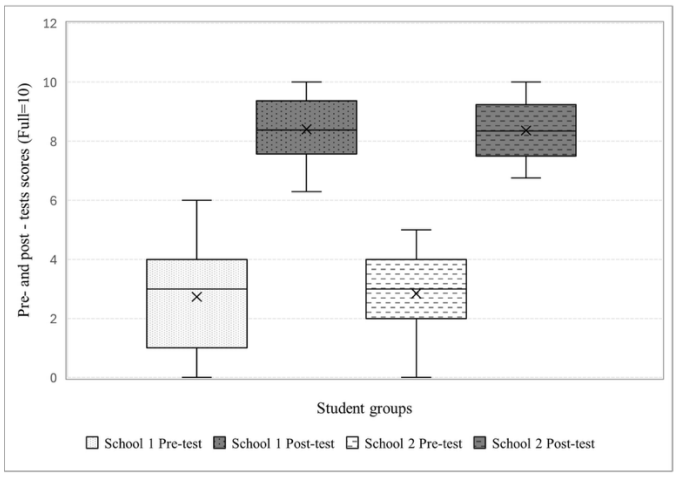


Figure: Distribution of student conceptual achievement scores before and after the intervention

Outcome: Average test scores (out of 10) rose from 2.78 to 8.40 at School 1 and from 2.85 to 8.49 at School 2, with normalized gains of 0.76 and 0.77. Students who started with low scores ended up close to higher-achieving peers. Student reasoning also shifted from fragmented, surface-level answers toward relational answers that connect diagrams, variables, and equations. Relational responses reached about 68–85% in the first two topics but only 52% in the fluid mechanics mini-laboratory, suggesting that topic needs extra support. In interviews, most students said that the step-by-step worksheets, peer discussion, demonstrations, and recorded lessons made physics easier to follow, more engaging, and less stressful. Because there was no comparison group and a researcher taught the lessons, the study cannot prove that the model alone caused these improvements.

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Related SDGs goal: 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Related publications:

1. Eambaipreuk A, Arayathanitkul K, Emarat N and Sharma M D (2021) Ways of incorporating active learning experiences: An exploration of worksheets over five years in a first year Thai physics course. *Eur. J. Phys.* 42 035703.
2. Benegas J and Flores J S (2014) Effectiveness of tutorials for introductory physics in Argentinean high schools. *Phys. Rev. ST Phys. Educ. Res.* 10 010110.
3. Bergmann J and Sams A (2012) Flip Your Classroom: Reach Every Student in Every Class Every Day. International Society for Technology in Education.
4. Crouch C H and Mazur E (2001) Peer instruction: Ten years of experience and results. *Am. J. Phys.* 69 970-7.