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Looking in detail at students' computational thinking

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Programming in Intro Physics

- What do students learn from computational physics problems?
- How do they use the visualizations produced by the programs?
- Do students ask different questions or reflect in different ways in computational tasks?

Thinkaloud Protocols

- Technology from cognitive science
- “Say whatever comes into your mind”
- This level of self-reporting
  - Is accurate
  - Does not influence subject’s reasoning

(Erikson & Simon)

Human Subjects

- Detailed study design must be approved by Institutional Review Board (IRB)
- Subject must sign informed consent form
- Subject must give explicit permission for videotaping
- Subject must give explicit permission to show videos to persons not involved in experiment

Pilot Study Design

- Study completed program (Spacecraft orbits Earth)
- Predict (draw) what will happen when program is run
- Did what you saw agree with your prediction?
- Task: Make the orbit circular
- Task: Write program to model a binary star

“Brian”

- Task: make the orbit circular

$$\left|\frac{d\vec{p}}{dt}\right| = \left|\vec{F}_{net}\right|$$

$$\frac{mv^2}{r} = G\frac{mM}{r^2}$$

$$v = \sqrt{\frac{GM}{r}}$$

Program code

Video

Brian wonders what is special about the particular initial conditions that produce a circular orbit

He isn't satisfied with trial and error, though he knows he could produce an orbit that appeared circular this way

He appears to be looking for a causal, or mechanistic, explanation of why the orbit becomes more circular as the initial speed increases.

This question would not naturally arise in the context of the closed form solution.

Not all students ask this question.