Teachers' intended learning outcomes around computation in high school physics

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INTRODUCTION

- **Next Generation Science Standards**[1] call for education of computational thinking
- ***Integrating Computational Science Across Michigan*** is a workshop that helps instructors teach computation in their physics classes

METHODS

1. **Interviewed teachers** (*N*=7) to explore course-level and activity-specific learning outcomes
2. Conducted a **thematic analysis**

Teacher	Class	Computational Activity
Abe	Phys. Sci. 2 Physics	Placing objects to spell name 1D elastic collisions Levers & mech. advantage
Burt	Physics	1D motion & kinematics
Carl	Physics	Momentum & 1D collisions Universal gravitation
Diane	Physics	Captain America in free fall
Emmett	Physics	Universal gravitation
Frank	AP Physics	Hooke's Law & energy transfer
George	AP Physics	Vertical spring-mass Bungee jumper

RESULTS & IMPLICATIONS

- Learning outcomes could be related to teachers' self-efficacy toward computation
- Teachers only used "observational" or "subjective" assessment strategies to evaluate students
- **Learning outcomes and assessment should be emphasized in the next workshop series**

Teacher interviews revealed computational **learning outcomes** focused on **computational thinking**, **learning** and **doing physics**, and giving students a **positive experience** in high school physics.

However, teachers **did not** have clearly defined **assessment strategies** for these learning outcomes.

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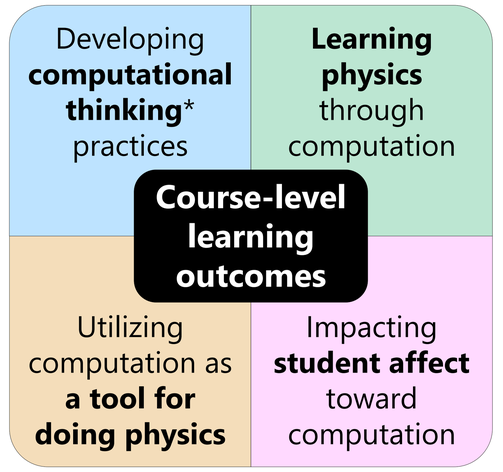
INTERVIEW DATA



***Computational thinking** theme includes ideas like writing code, programming, debugging, troubleshooting, iterative logic, modeling, simulating, and testing/assessing solutions.

Interview question: *"What are your overall learning objectives for students involving computation in your course?"*

Emmett: *"I want students to be comfortable **writing code** so that they are familiar with it as a problem solving skill…So that they could say, 'Maybe we can **put this into a simulation** really quickly and **see what we get**.'"*
– **Computational thinking**

George: *"The goal of computation is for them to be able to write or re-work the code, using their physics knowledge, to **understand the physics more deeply**."*
– **Learning physics** through computation

Diane: *"As far as with the physics, just to see that **there is another way we can do it**. We do it in graphs, we do it in motion, we do it in video, we do it on paper, and now we've got the computation as well."*
– Computation as **a tool for doing physics**

Carl: *"Our goal is that when the students go on, they've got a little understanding of coding so they're **not afraid** of it…I think if they got an entry and they just know the logic of it, it opens doors that otherwise would remain closed. They'd be afraid of it. They'd feel **intimidated**."*
– **Student affect** toward computation

Interview question: *"How do you know if your students are meeting your goals?"*

Emmett: *"That's still an **unsolved mystery** as far as I'm concerned. Trying to definitively ascribe some outcome to a particular individual is really hard to do. Just by its nature, code is easy to share… I'm working on it, but **I'm not sure what to do**."*

Diane: *"I realized I didn't necessarily know how much or how little some of the individuals knew. So, I was thinking **I needed to do some sort of evaluation**. **We never did**, but that's kind of where I was getting to."*

REFERENCES

[1] National Research Council, "A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas," Washington D.C.: The National Academies Press (2012).

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