Student-identified themes around computation in high school physics

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QUESTIONS

The six questions we asked to high school physics students are listed below:

1. *How do you feel about learning computation in your science class?*
2. *Why is computation useful for science?*
3. *Based on your experience, how easy/difficult has it been to learn coding in your science class?*
4. *When coding, do you feel it is important to understand every line of code before you can use it effectively?*
5. *When using code to solve a problem, how do your physics ideas apply to the problem?*
6. *How does learning about coding change your ideas about how physics works?*

RESULTS

Major themes with large variation in student responses:

- Usefulness of Computation (USE)
- Applicability of Physics Ideas When Coding (APP)
- Computational Thinking Practices (CT)

IMPLICATIONS

These categories will guide the creation of a larger statement based survey that will be adaptable to a specific teacher's goals for their unique classroom.

"I've enjoyed learning computation so far. I like it because it was a good way to use my head and what I'd learned in physics. Also, learning even a basic understanding of coding felt useful yet fun."

Our pilot questionnaire explored student perceptions around **computational utility**, **physics applicability**, and **computational thinking** to inform the development of a computational attitudes survey.

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Step 1: Interviewed teachers to identify their intended learning outcomes

Step 2: Reworded CLASS questions that were most aligned with teacher interviews

Step 3: Piloted the questionnaire to a class of *N*=15 students and updated wording

Step 4: Implemented the questionnaire to a larger set of students and analyzed responses

THREE MAIN THEMES:

Usefulness of Computation (USE)	
Learnability	"It can be used in various branches of science to help us (as students) learn."
Future	"Computation is the future of science and the future of the world. An astounding number of jobs are coding based and this number will only increase. It is best to be prepared for the future."
Physics	"It can show science applied. You can use it to run simulations or test physics."
Accuracy	"It can also help data be more specific and closest to the exact number as it is computerized."
Computational Thinking	"It can be used to create programs to demonstrate computer science."

Applicability of Physics Ideas When Coding (APP)	
Physics-specific	"Newton's laws apply, along with things like speed, velocity, acceleration, time, etc."
Equations	"Physics is a lot of equations and plugging in numbers, and that is very similar to coding."
Learnability	"Knowing the physics behind the coding can help you put the code together and understand what you're doing."
Interdisciplinary	"They are the basis of all code, so it is necessary to understand the basics."

Computational Thinking Practices (CT)	
Data Management	"It's very useful for data to be stored on computers and processed on computers."
Modeling	"It can be used as a model to show how things would move based on the properties of physics."
Visualization	"You are able to see different things being talked about and see a computer version of them."
Testing/ Prediciting	"You might be able to test how things will react on a computer and get a preview."

TWO ADDITIONAL THEMES:

Importance of Understanding Each Line of Code (IMP)	
Programming-specific	"It's vital to much sure every letter, punctuation, and parenthesis is right."
Learnability	"Copying and pasting info you don't understand won't benefit you in any way."
Efficiency	"You'd make less mistakes and take less time to complete the code."
Troubleshooting	"You have to know what each line does so you know what to do if something goes wrong."

Difficulty of Computation (DIF)	
Difficult	"It has been very hard from my experience."
Easy	"Based on my experience coding has been really easy to learn."
Both	"It's been easy at times as well as difficult, so in the middle."
Difficult then Easy	"It was hard to get used to but once I got comfortable using it it seemed easier."

REFERENCES

[1] W.K. Adams, et.al New instrument for measuring student beliefs about physics and learning physics: The Colorado Learning Attitudes about Science Survey," Phys. Rev. ST Phys. Educ. Res. **2**(1), 010101 (2006).

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