

PURDUE

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CS4EDU

COMPUTATIONAL THINKING IN PRE-SERVICE TEACHER EDUCATION: INTEGRATING CT MODULES IN THE CURRICULUM

Ninger Zhou

Xuemei Wu

Dr. Aman Yadav

Dr. James Lehman

Chris Mayfield

Dr. Tim Korb

Dr. Susanne Hambruch



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CS4EDU <http://cs4edu.cs.purdue.edu>

- CS4EDU project is to create new pathways for undergraduate education majors to become computationally educated secondary teachers.
- Faculty in the Department of Computer Science and the College of Education at Purdue University cooperated in creating a Computer Science Teaching Endorsement program.
- The CT Modules introduced basic CS concepts and encouraged students to participate in the endorsement program.

WHAT IS COMPUTATIONAL THINKING

- **Definition**

CT involves solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science.

CT is more than using technology and computers, it involves thinking process and strategies that are characteristic of CS

THE ROLE OF CT IN K-12

- A fundamental skill (Wing, 2006, Lu&Fletcher, 2009)
- Enable students to think like computer scientists (Wing, 2006)
- Enhance problem solving skills

Ubiquitous computing is to today as
computational thinking is to
tomorrow.

----Wing, 2006

WHY INTRODUCING CT IN TEACHER ED?

Teachers can facilitate CT more effectively when they:

- identify the benefits of CT in problem solving (daily life and educational settings)
- interpret CT meaningfully (relate to CT from personal experience)
- examine teaching strategies for integrating CT into their own subject

CT IN TEACHER EDUCATION—OUR GOALS

- Introduce the concepts and benefits of CT
- Establish meaningful understanding of CT
- Provide examples of CT in academic disciplines

RESEARCH

- Sample: 155 elementary and secondary education majors enrolled in an introductory educational psychology course (Learning and Motivation) at Purdue
- Intervention: The computational thinking module was integrated in the Learning and Motivation course, replacing the problem solving lectures
- Features: I-clickers were used to encourage participation and provide immediate feedback
- Survey: Pre and Post open-ended survey to assess their understanding of CT

CT MODULE DESIGN

- **Purpose:**

- Introduce the concepts and benefits of CT
- Apply CT to problem solving in daily life and learning
- Demonstrate the integration of CT into different disciplines

- **Procedure:**

- Lecture 1: basic concepts and application
- Lecture 2: CT in subject areas

- **Obstacles**

- Facilitate pre-service teachers from different background to relate to CT in a meaningful way
- Provide examples for teaching CT in each subject area

LECTURE 1 CT CONCEPTS

The key elements of CT

- Abstraction
 - Decomposition of problems
 - Identify rules that apply to other situations (transfer)
- Algorithm
 - Procedure
 - PBJ sandwich example

CLICKER QUESTION

Which of the following is NOT like the others?

- [A] People standing in line at the store
- [B] List of print jobs waiting to be printed
- [C] Set of tennis balls in their container
- [D] Vehicles lined up behind a toll booth
- [E] Patients waiting to see the doctor

CLICKER QUESTION 5 (ANSWER)

Which of the following is NOT like the others?

- [A] People standing in line at the store (queue)
- [B] List of print jobs waiting to be printed (queue)
- [C] Set of tennis balls in their container (stack)
- [D] Vehicles lined up behind a toll booth (queue)
- [E] Patients waiting to see the doctor (queue)



LECTURE 1 CT CONCEPTS

- Logical thinking
 - Inductive reasoning---math problems
 - Deductive reasoning---from general to specific
- Debugging
 - Example: fixing lamp

KEY ELEMENTS OF CT

- Algorithm
- Abstraction
- Logical thinking
- Debugging

LECTURE 2 CT IN K-12

- Benefits of teaching CT
 - Abstraction: identify the rules and generalize to other similar problems
 - Automation: the automated processes
 - Enhance problem solving skills
 - Encourage creativity
 - Move students beyond technology literacy

LECTURE 2 CT IN K-12

- Application of CT in classrooms
 - Math---abstract and generalize rules to solving similar problems
 - Science---simulation of chemistry or physics experiment, etc
 - Social sciences---data modeling, google public data

EXAMPLE APPLICATIONS OF CT IN K-12

Elementary Education

Breaking down a simple daily task such as brushing teeth into 15 separate and distinct steps to build foundations for understanding computer performance.

English

Identifying the similarities between raps and poetry, and matching rappers with poets based on their similar styles and characteristics.

History

Studying historical events and statistic data to investigate what caused immigrations rates to change over time.

Computational Thinking Survey

Participants:

- **155 students in teacher education program were emailed survey links**
- **100 (65%) responded**

		Number Of Respondents
Gender	Female	78
	Male	22
Level	Elementary	55
	Secondary	45

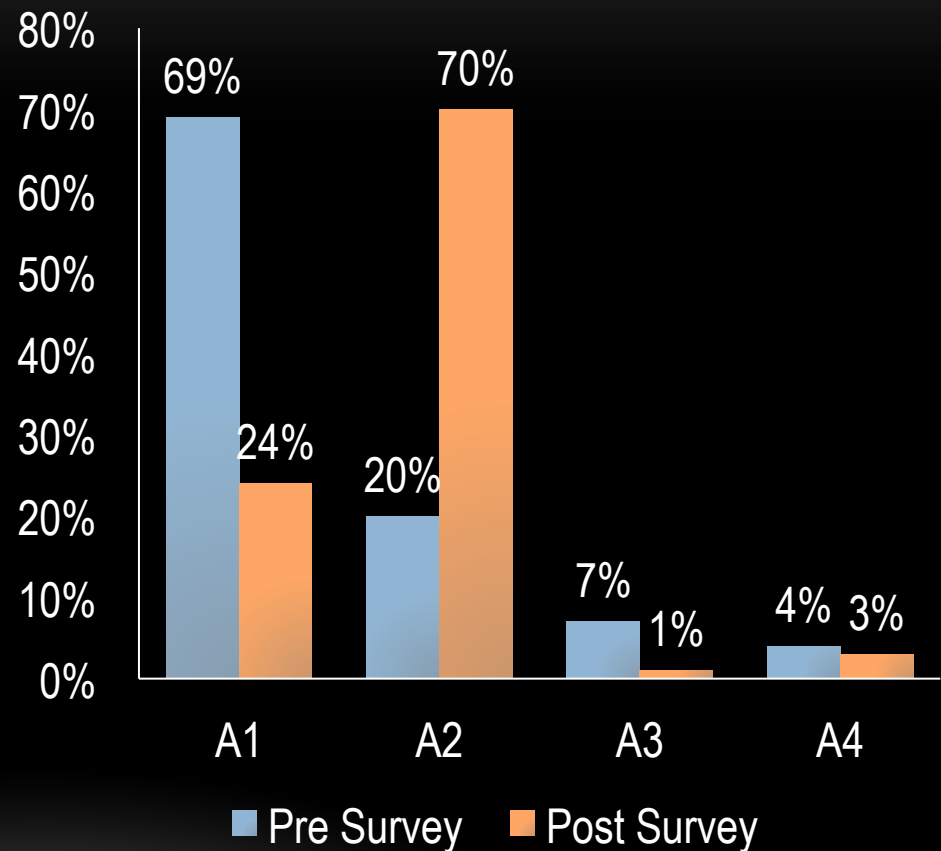
Survey results--Views on computing

A1: To use computers and/or technology to solve a problem and make tasks easier

A2: The process of solving problems ,not necessarily involving the use of computers and technology

A3: The study of computers

A4: Other



Views on Computational Thinking

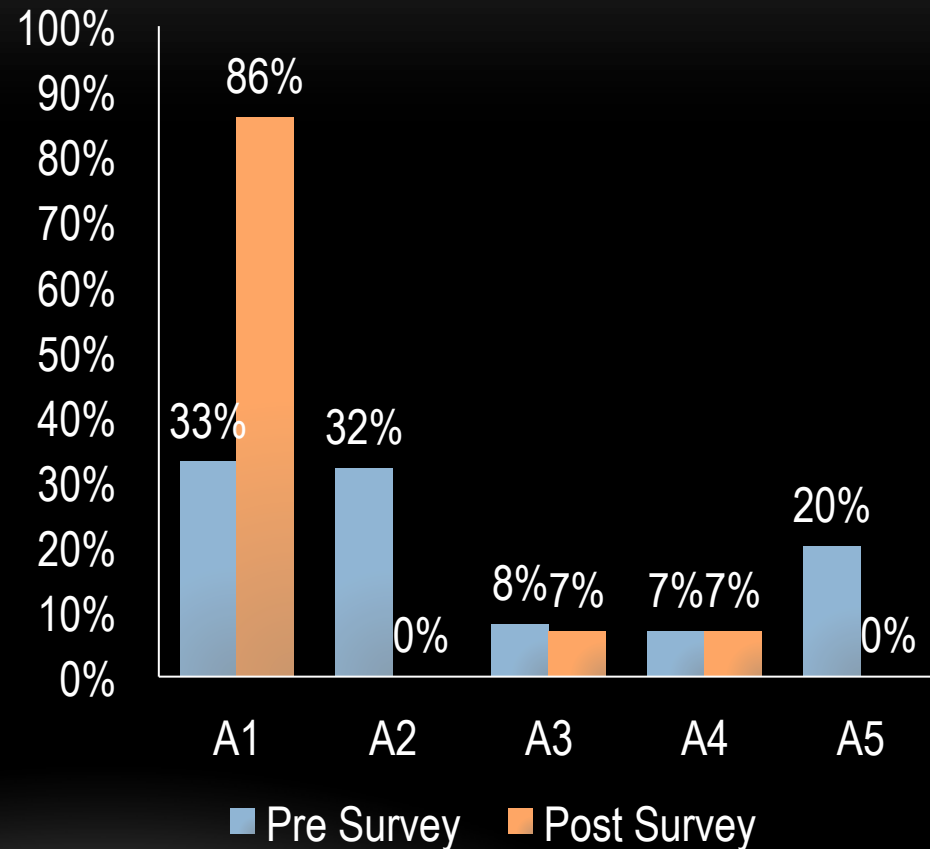
A1: The process of solving problems

A2: To use computers and/or technology to solve a problem or make tasks easier

A3: The study of computers; solving problems like a computer

A4: Other

A5: Not sure



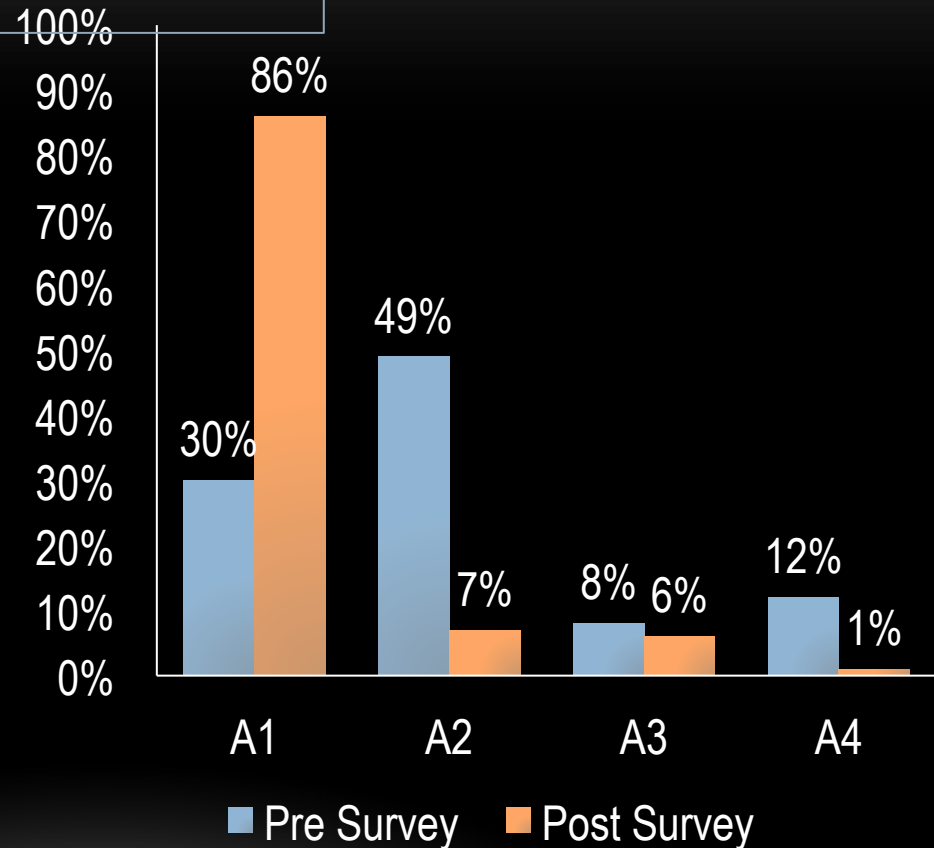
Integrating CT into classroom

A1: promote problem solving skills/ critical thinking in the classroom

A2: utilizing computers and technology in the classroom

A3: Other

A4: no idea



DISCUSSION

We found:

- Changed and enriched pre-service teachers' understanding of CT
- Shaped positive attitude towards computing
- provided examples for integrating CT into classrooms
- Enhanced pre-service teachers' awareness of applying CT principles in teaching

FUTURE DIRECTION

- Conduct quasi-experimental study to examine the benefits of CT module in Learning and Motivation course
- Develop a CT webquest activity for the Introduction to Educational Technology course (required for education majors)
- Attract education students into computing courses that emphasize computer science principles (i.e., not just traditional programming courses).
- Identify and interview students who attended the CT modules and later selected CS related courses

Wiki link : <http://cs4edu.cs.purdue.edu/>