Infusing Computational Thinking in Teacher Preparation: Examining Preservice Teacher Knowledge, Attitudes, and Practice

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UNIVERSITY OF DELAWARE

Presentation Agenda

- Background
- Research Purposes
- Research Context
- Methods
- Findings
- Conclusions & Implications
- Future Research Directions

Background



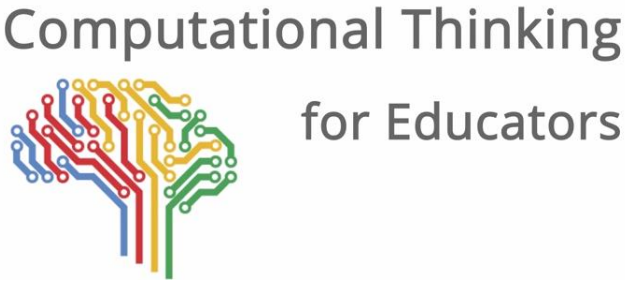
all students learn concepts and skills of computer science

Computational Thinking

(Bowers and Falkner, 2015)

Computational Thinking (CT)

- A fundamental skill of analytical thinking for everyone (Wing, 2006)
- Scientific practices (CCSS, 2010; NGSS, 2013)
- A skill needed to engage and thrive in a digital world (ISTE, 2016)



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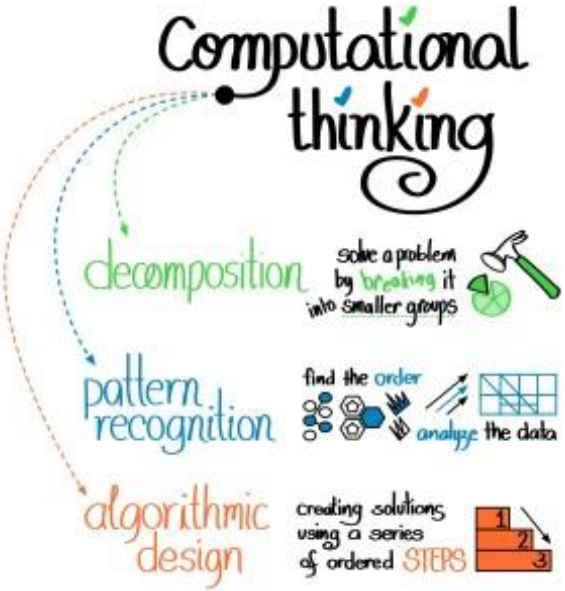
Defining Computational Thinking in K-8

- *Problem Decomposition*
- *Algorithmic Thinking*
- *Abstraction*
- *Data Collection, Analysis & Representation*
- *Automation*
- *Parallelization*
- *Simulation*

(CSTA & ISTE, 2011; NRC, 2010)



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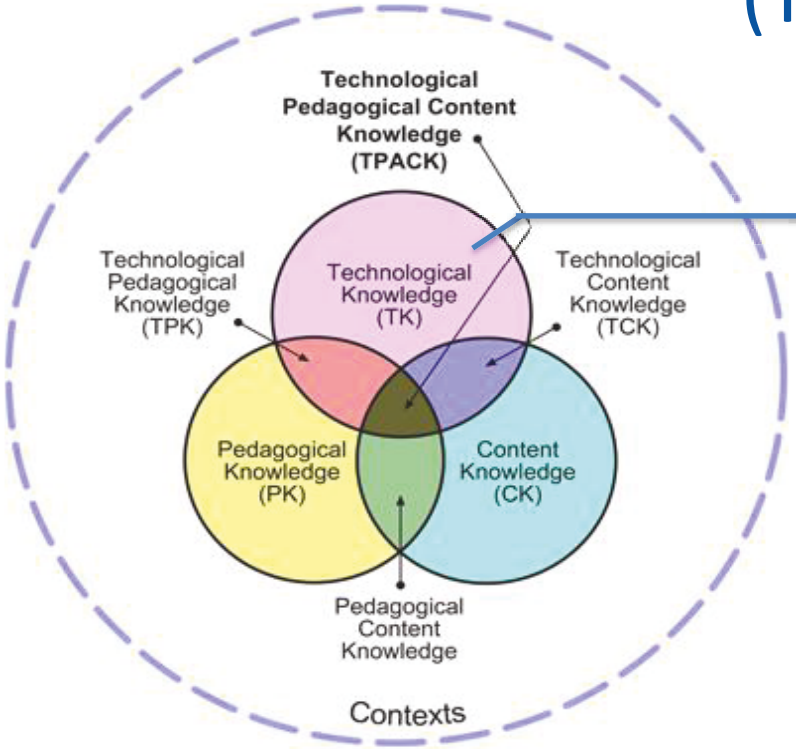
Teachers

To help future teachers develop an understanding of CT and its connection to their curricular context !

(Barr & Stephenson, 2011; Yadav et al, 2016; 2017)

Technological Pedagogical Content Knowledge (TPACK)



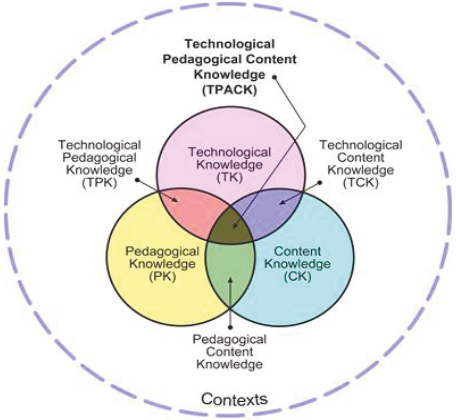
Technological Knowledge (TK)

Computational Tools

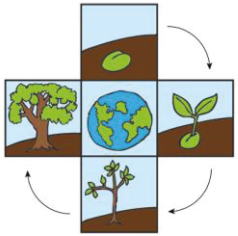
CT-related Skills & Practices

TK-CT

(Angeli et al., 2016; Mishra & Koehler, 2006)



COMPUTATIONAL THINKING



TPACK-CT

(Shinas et al., 2015; Yilmaz-Ozden et al., 2016)

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Research Questions

- How does participation in a CT-infused educational technology course influence pre-service teachers' knowledge of CT-related concepts, computing tools and dispositions that can be used within the context of disciplinary content and pedagogical knowledge?

  TK-CT

- How is CT-related TPACK represented in pre-service teachers' course materials?

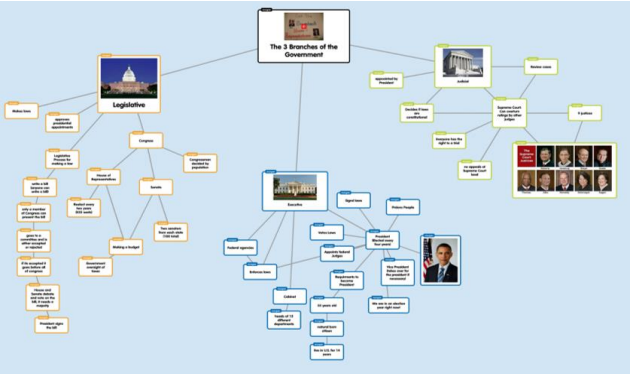
  TPACK-CT

Research Context

- Situated in a four-year teacher education program
  - General Studies; Professional Studies; Concentration Courses.[Field Experiences]
  - Elementary (K-5) & Middle School (6-8) Teacher Certification.

- CT-Infused Educational Technology Course: TK-CT development & Implementation
  - CT-related Concepts;
  - Computing Tools;
  - TPACK-CT Practices.

Computing Tools	Course Activities	CT Supported Concepts
Interactive Whiteboards	Participants observe teacher use of interactive whiteboards in elementary classrooms, engage in hands-on investigations, and learn to identify quality resources on Smart Exchange. Subsequently, participants generate lesson ideas related to their content area that integrate interactive whiteboard resources, which can support key CT skills. Examples include resources used to: represent a phenomenon such as prey and predator relationship, sequence events, represent data or sort information.	Algorithmic Thinking Abstraction Data Representation Automation
Internet	Participants identify a topic of interest and learn to conduct Internet research effectively by identifying keywords and using boolean logic and operators. They also learn to estimate the readability of online content and evaluate the quality of online resources for teaching. Subsequently, participants apply their skills in a review of an online resource related to their content area.	Problem Decomposition Abstraction Automation
Programming (Scratch)	Participants learn to work with computer science ideas through unplugged activities (i.e., done without a computer) and the Hour of Code (code.org). They also create computational products with Scratch - an object oriented programming language. Subsequently, they review lessons that integrate programming and CT through the ScratchED community (http://scratched.gse.harvard.edu/). Finally, participants design a learning activity in a content area that involves Scratch programming	Problem Decomposition Algorithmic Thinking Abstraction Automation Simulation
Concept Mapping	Participants practice using concept-mapping software, reflect on their experience and plan one lesson idea that integrates concept mapping in a content area of their choice to support student development of CT skills (e.g., decompose a math problem, model a physical phenomenon such as the life cycle of a butterfly, sequence events in a story, or plan an essay).	Problem Decomposition Algorithmic Thinking Abstraction
Collaboration Tools	Participants select and read an article focusing on multiple approaches to developing student CT knowledge and skills. These include board games, robotics, and programming. Subsequently, participants use a multimedia/collaboration tool of their choice (e.g., Gloglster, Voicethread, Storybird) to represent their understanding of the reading to their classmates.	Problem Decomposition Algorithmic Thinking Abstraction Automation



Methods

- Participants
  - 21 Pre-service Teachers
  - Subject Areas: Literacy (5), Math (3), Social Studies (8), Science (5)
- Data Sources
  - Survey: Depositions and Knowledge Related to CT
  - Course Materials: Representation of TPACK-CT
- Data Analysis
  - T-test
  - Constant Comparative Method
  - Technology Integration Assessment Rubric

Survey -- Depositions and Knowledge Related to CT

- Definition
- Comfort
- Interest
- Use in the Classroom
- Career/Future use
- Knowledge and Beliefs

(Yadav et al., 2014)

Case Development Project-- Representation of TPACK-CT

- Case Narrative
  - Design & Implementation
- Case Reflection
  - Support the development of students' CT skills

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- Data Sources
  - Survey: Depositions and Knowledge Related to CT
  - Course Materials: Representation of TPACK-CT
- **Data Analysis**
  - **T-test**
  - **Constant Comparative Method (Hatch 2002; Miles & Huberman, 1994)**
  - **Technology Integration Assessment Rubric (Harris, Grandgenett, & Hofer, 2010)**

Finding

Dispositions and Knowledge Related to CT (TK-CT)

- Significant gain ($p < 0.05$) on *definition, knowledge and beliefs*

Constructs	Number of Items	Mean for Pre Survey	Mean for Post Survey	Standard Deviation	*t*	*p* Significance (Two-Tailed)	Effect Size (*d*)
Definition	4	2.70	3.07	0.38	4.27	.000**	1.05
Comfort	6	3.30	3.40	0.40	1.14	.268	0.25
Interest	4	2.71	2.80	0.43	0.94	.359	0.13
Classroom	2	3.26	3.45	0.53	1.51	.149	0.47
Career	5	3.35	3.41	0.46	0.60	.555	0.17
Knowledge and Belief	5	3.21	3.47	0.35	3.31	.004**	0.58
Total	26	3.11	3.28	0.26	2.92	.009**	0.56

*$p<.05$. **$p<.01$ and Effect size < 0.3 is small, 0.3–0.5 is medium, and >0.5 is large (Cohen, 1988).

Finding

Dispositions and Knowledge Related to CT (TK-CT)

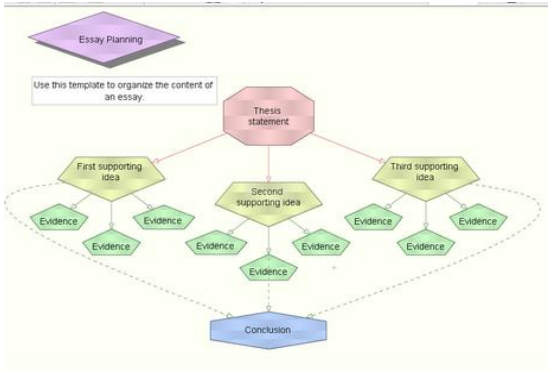
- **What do you think the term Computational Thinking means?**
  - *Pre: no one has heard of the term CT;*
  - *Post: problem solving; abstraction; logical thinking etc.*
- **How would you implement computational thinking into your future classroom?**
  - *Pre: must use computer/ technology;*
  - *Post: certain computational tools; non-technology tool; connected to content areas.*

Finding

Representation of TPACK-CT in Participants' Course Materials

Description of Cases Enacted by Participants

	Number
Content Focus	
Social Studies	8
English	5
Science	5
Math	3
Technology	
Interactive whiteboard applications	12
Concept mapping tools	6
Internet resources	3
CT Skills Supported	
Automation	15
Problem Decomposition	13
Data Representation	12
Algorithmic Thinking	9
Abstraction	4
Simulation	-
Parallelization	-



Finding

Representation of TPACK-CT in Participants' Course Materials

Harper's Geography Lesson

- Read Aloud
  - Water Pollution (Saving Our World) by Sean Price (2008)
- Discussion
- **Concept mapping tool**
  - Causes of pollution
  - Pollution effects on the natural environment
  - Actions that could help prevent water pollution.

- *"I provided students with an opportunity to process, discuss, organize and model their ideas. The electronic concept map allowed students to move beyond content, think abstractly and use technology to organize their thinking more efficiently."*

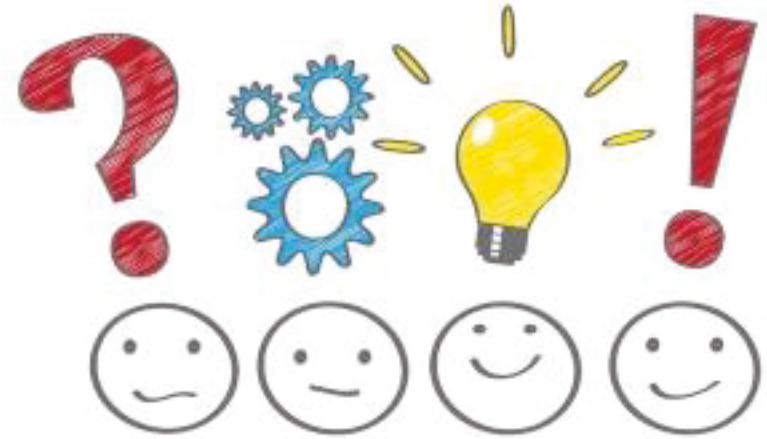
Conclusions & Implications

- Conclusions
  - Participation in the course helped pre-service teachers develop a better understanding of CT concepts and practices as well as its value in classroom teaching. TK-CT
  - The ability to weave knowledge of CT concepts, computing tools and practices with content and pedagogy (TPACK-CT) varied among participants. TPACK-CT

- Implications for Teacher Preparation Program
  - Infuse CT across teacher education curricula to foster deeper understanding of CT concepts;
  - Provide supports to pre- and in-service teachers to learn about computing tools.

Future Research Directions

- Explore pedagogical strategies for infusing CT knowledge and skills in teacher education curricula.
- Provide more precise definitions of TPACK-CT.
- Examine TPACK-CT in relation to specific content areas:
  - What would TPACK-CT look like in specific content areas at the K-8 level?



THANK YOU!