Assessing the Development of Computer Science Pedagogical Content Knowledge in the TEALS Program

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One of the critical barriers to increasing pre-collegiate computer science course offerings in the U.S. is a lack of qualified computer science teachers. Programs such as TEALS, a teacher preparation program pairing high school teachers with computing professionals to offer CS courses, provide opportunities for in-service teachers to gain experience teaching computer science. However, it is not clear whether the high school teachers develop sufficient pedagogical expertise to sustain high-quality computer science course offerings at their schools. Furthermore, the field of computer science education lacks valid and reliable ways of measuring pedagogical content knowledge (PCK), a construct that describes the knowledge teachers need for effective instruction. In this poster, the authors present these results from the first year of a three-year NSF grant to study how TEALS participation influences novice computer science teachers' PCK: 1) a theoretical framework describing the critical components of CS PCK, 2) the results of the first field test of a CS PCK assessment, including the psychometric properties of the assessment, and 3) a comparison of how teachers performed on the assessment at the beginning and end of their first year of computer science teaching and how they performed relative to their computing professional mentors.

Keywords: computer science education; pedagogy; pedagogical content knowledge; high school; teacher preparation

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Background

- The majority of K-12 computer science (CS) teachers lack either teaching experience or CS experience (Gal-Ezer & Stephenson, 2010).
- Neither teacher preparation programs nor state teacher certification agencies are equipped to help people become highly qualified CS teachers (Gal-Ezer & Stephenson, 2010).
- The field needs to create alternate ways of preparing CS teachers

What is TEALS?

- Founded in 2009, TEALS is a non-profit Microsoft YouthSpark program.
- TEALS partners with US high schools to help them launch and grow a sustainable CS program.
- TEALS recruits and trains volunteer CS professionals and pairs them with high school teachers to team teach CS.

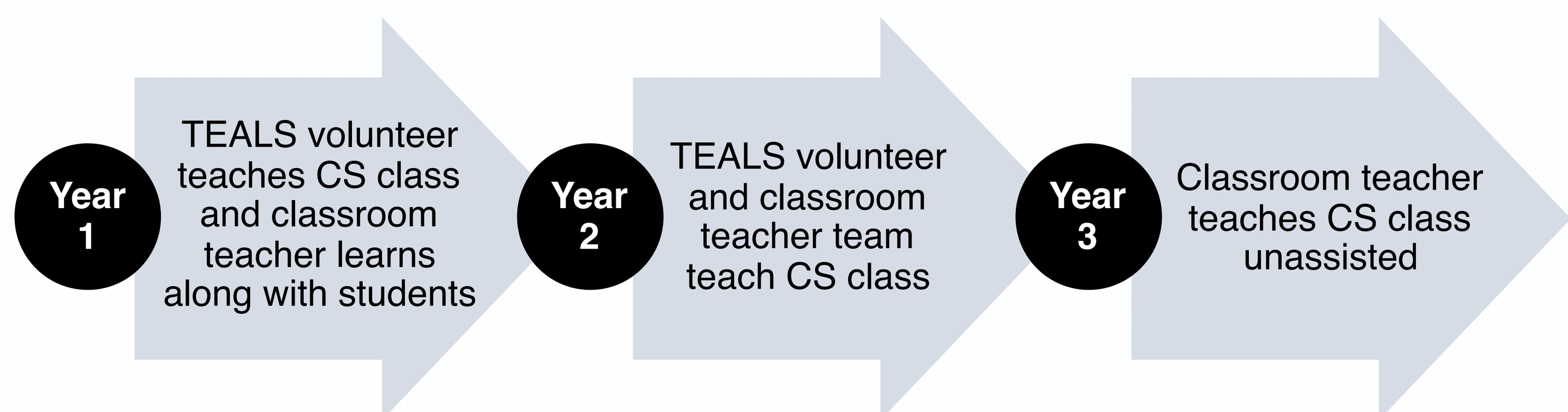
TEALS Classes

Introduction to Computer Science	AP Computer Science A
• Pre-AP course that teaches students to program using Snap!	• Introduces students to the fundamentals of object-oriented programming in Java

TEALS Co-Teaching Model

TEALS Team

Volunteer	Classroom Teacher
• Industry professional with expert knowledge of computer science	• High school teacher who may or may not have computer science background



For more information about the TEALS program, visit http://www.tealsk12.org.

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Project Goals

- To study on-the-job CS teacher preparation in the context of the TEALS program
  - Mixed-methods study with surveys, assessments, classroom observations, and interviews
  - Understand the scope and nature of classroom teachers' knowledge change in this learning environment
- Develop a theoretical framework for CS pedagogical content knowledge (CSPCK) and a preliminary assessment

CSPCK Framework

- **Pedagogical content knowledge** (PCK) is the specific knowledge needed to teach a particular subject (Schulman, 1986).
- PCK is an important aspect of teacher preparation.
- There is a lack of knowledge about how PCK develops in CS teachers that makes it difficult to create quality professional development for CS teachers.

Category Detail	Description
I. Planning, Selecting, Evaluating	
Tool Selection	• Identify tools, language, or other environments • Describe the pros and cons of each with respect to student engagement, learning, and support
Visualizations	• Describe the usefulness of visualizations • Plan appropriately for their use in class
Scaffolds/Supports	• Describe the purpose of scaffolds and supports as it relates to CS • Select and describe commonly used supports • describe how a particular scaffold or support will affect student learning of a particular CS concept
Topic Decomposition	• Provide a detailed decomposition of a particular topic including potential stumbling blocks for students.
Pacing	• Provide appropriate pacing for topical concepts
Adapt instructional sequence based on data	• Adapt an instructional plan based on data collected during a lesson
II. Instruction/Differentiation	
Adapt based on formative assessment	• Suggest appropriate formative assessment strategies • Describe the type of data collected by a type of formative assessment • Recommend lesson adaptations based on provided data
Multiple Explanations	• Provide multiple explanations for concepts to suit individual learner's needs
III. Assessment	
Formative and Summative	• State the purpose of formative (within lesson) and summative (end of lesson/unit) assessments • Recognize examples of each
Misconceptions	• Recognize common misconceptions • Use the misconceptions as distractors for created assessment items
Single Goal Questions	• Select questions that focus on a single instructional goal and do not rely on extraneous knowledge
Grading to a Rubric	• Apply rubric grading to student work

Data Analysis and Results

Participants (2014-2015 1st year TEALS implementations)

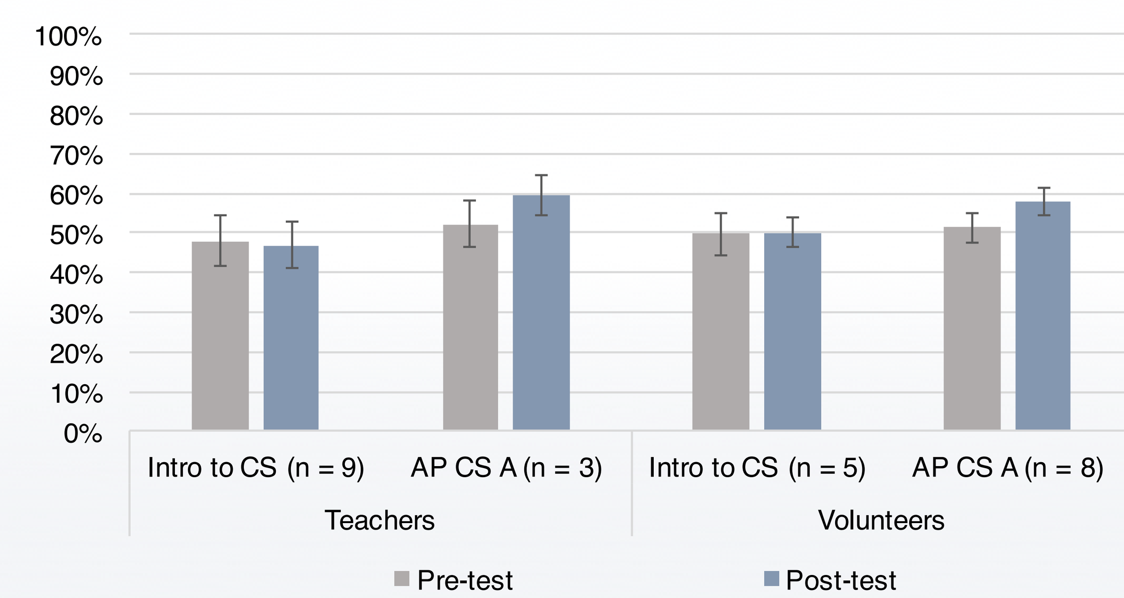
	Teachers (n = 12)	Volunteers (n = 13)
Demographics		
# females	5	2
# underrepresented ethnicity in CS	2	1
Mean age	42.8 years (SD = 11.1)	42.6 years (SD = 10.8)
Prior CS Teaching Experience		
# with no prior CS teaching experience	7	8
# with 1-3 years CS teaching experience	4	3

Post-test Item Performance and Reliability (α = 0.52)

Item	Construct	# Parts	Mean % of Possible Points	α if Item Deleted	Item – Total Correlation
1	Planning, Selecting, Evaluating	1	40.0%	0.52	0.40
2	Planning, Selecting, Evaluating & Instruction/Differentiation	1	97.3%	0.51	0.24
3	Planning, Selecting, Evaluating	7	65.4%	0.49	0.40
4	Assessment	6	41.1%	0.49	0.38
5	Assessment	5	73.7%	0.41	0.65
6	Planning, Selecting, Evaluating	7	60.0%	0.51	0.33
7	Planning, Selecting, Evaluating		--- Not scored ---		
8	Planning, Selecting, Evaluating	3	66.7%	0.52	0.22
9	Planning, Selecting, Evaluating	60	44.4%	0.51	0.30
10	Planning, Selecting, Evaluating & Instruction/Differentiation	1	90.4%	0.44	0.57
11	Instruction/Differentiation	1	40.0%	0.55	0.39
12	Planning, Selecting, Evaluating	1	32.0%	0.43	0.64

If each part is treated as a separate item in the reliability analysis, α = 0.81

Mean Scores (max points = 134)



Error bars represent ±1 SE

ANCOVA results:

- *Pre-test*
  $F(1, 21) = 15.203$, $p < .001$
- *Course*
  $F(1, 21) = 4.903$, $p = .034$
- *Participant type*
  $F(1, 21) = 1.477$, $p = 0.238$