Middle school teachers' self-efficacy in teaching computer science and digital literacy:
Impact of the CS Pathways professional development program

Contact email: gyu@albany.edu
CS Pathways website: https://cspathways.org/

Gillian Bausch, Lijun Ni
University at Albany, SUNY

Fred Martin, Hsien-Yuan Hsu, Bernardo Feliciano
University of Massachusetts Lowell

Background and Motivation

- Teachers' self-efficacy is a significant construct since it can predict the behavior and performance of teachers (Skaalvik & Skaalvik, 2016).
- Professional development(PD) has been used as an effective way to enhance teacher's self-efficacy (Desimone, 2009).
- Studies on measuring teachers' self-efficacy in PD programs remain insufficient (Zhou, et al., 2020; Menekse, 2015).
- The CS Pathways RPP project aims to engage middle school teachers from three districts in NY and MA in learning and implementing a CSDL curriculum focused on developing apps for social and community good.

Aims of the study

Th study aims to explore the impact of the CS Pathways PD on building middle school teachers' self-efficacy in teaching computer science and digital literacy (CSDL) curriculum.
RQ 1: Which attributes (factors) explain a teacher's self-efficacy?
- Of the teachers with high self-efficacy, what features do they share?
- Of the teachers with low self-efficacy, what features are they lacking?

RQ 2: How did teachers' participation in the CS Pathways PD program influence their self-efficacy in teaching the CSDL curriculum?

CS Pathways PD

- PD format: moved from hybrid to virtual meetings starting in March 2020; established bi-weekly PD meetings as a whole project;
- PD content: district priorities using the SCRIPT Visions Toolkit, CSDL knowledge, building mobile apps, and conversations about teachers' own learning challenges.

Data Collection and Data Analysis

- **19 middle school teachers**: 12 in Technology/Computer, 7 in other content areas (e.g. Math, Science, Civics etc.)
- **All 19 teachers completed the end-of-year survey** examining teachers' self-efficacy on:
  - 1) digital literacy knowledge; 2) app creation; 3) teaching CSDL;
  - 23 items (*Cronbach's alpha* = 0.93);
- **10 teachers** in the semi-structured interview.

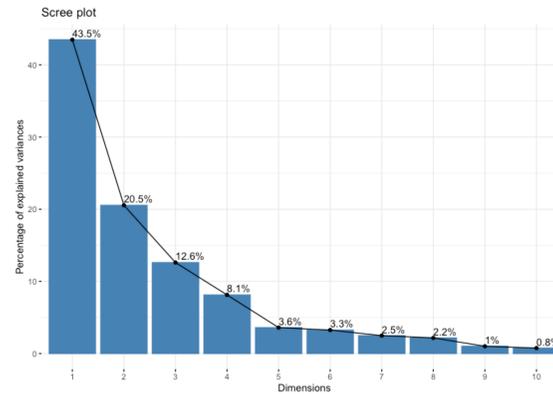|	Quantitative Analysis	Qualitative Analysis
Goal	to study the attributes of the teachers' self-efficacy pattern	to understand teachers' perceptions on how the PD built their self-efficacy
Instrument	End-of-year survey	Teacher interview
Data analysis	Principal Component Analysis (PCA)	Thematic Coding using NVivo

Results and Discussion

Figure 1. Scree plot

PCA results and discussion:

- The three components account for 76.7% of the total variance in the original data;
- The first principal component (PC1) captures teachers with strong confidence and self-efficacy in app creation and teaching CSDL after the PD (PC1 = 43.5%);
- PC2 indicates that teachers with relatively less confidence on their DL knowledge gained more confidence in app creation, but less self-reported capacity in teaching CSDL (PC2 = 20.6%);
- PC3 represents teachers with strong digital literacy knowledge, but very low capacity in teaching CSDL after the PD (PC3 = 12.7%);
- The higher the teachers' self-efficacy, the more likely they are able to create apps relevant and exciting to students (F7-16); as a consequence, the more competent they are and the more confidence they have in teaching CSDL.

Table 1. *Selected Factor Loadings for Linguistic Features in all Three Dimensions ($\lambda \geq .20$)*
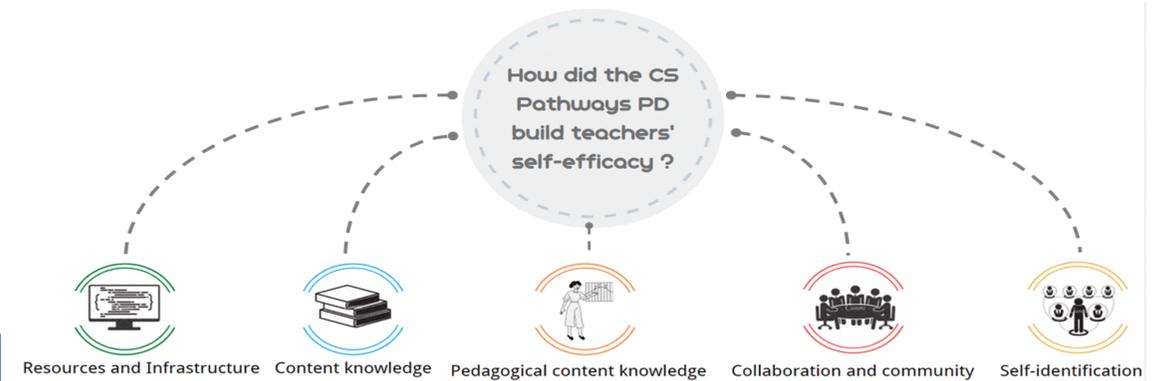
Dimension 1	
Teacher Self-efficacy Feature Indices	Loadings
F1: Set up new software on tablets	-.235
F7: Use any apps	-.212
F8: Use an app to help you solve a problem in your community	-.220
F9: Create an app using App Inventor	-.256
F10: Create an app to solve a community problem	-.235
F11: Create an app that is relevant and exciting to students	-.264
F12: Create an app that has an image	-.241
F13: Create an app that has multiple images	-.223
F14: Create an app that has sound	-.223
F16: Create an app that uses variables and lists	-.216
F17: Teach digital literacy skills as part of a computer science curriculum	-.237
F18: Teach students file naming management that is relevant to apps	-.246
F20: Teach students how to edit or select audio files for use in an app	-.223
F22: Integrate app development into my existing curriculum	-.204
F23: Create multimedia presentations	-.265
Dimension 2	
Teacher Self-efficacy Features Indices	Loadings
F2: Ensure the tablets are charged and ready for use by students	-.380
F3: Implements a system of distributing tablets to students for class use	-.405
F4: Implement a system of gathering tablets and returning	-.405
F12: Create an app that has an image	.225
F13: Create an app that has multiple images	.256
F14: Create an app that has sound	.256
F15: Create an app that has multiple screens	.264
F16: Create an app that uses variables and lists	.230
F21:Manage teams of students working collaboratively to develop apps	-.272
Dimension 3	
Teacher Self-efficacy Feature Indices	Loadings
F5: Trouble shoot hardware problems with tablets	.382
F6: Trouble shoot software problems with tablets	.457
F7: Use any apps	.326
F8: Use an app to help you solve a problem in your community	.252
F19: Teach students how to use resize images to use in an app	-.334
F21: Manage teams of students working collaboratively to develop apps	-.238

Note. F1- F6 Digital literacy knowledge;
F7-F16 App creation ability;
F17-F23 teaching CSDL.

Interview results and discussion: *Teachers' perceptions*

Resources and Infrastructure | Content knowledge | Pedagogical content knowledge | Collaboration and community | Self-identification

Resources and Infrastructure
- **Positive Evidence**: - PD introduced the vast existing resources on teaching CS;
- **Opportunity to improve**: - Build infrastructures to share resources and to further encourage network building; - Develop either holistic or summative assessment to help evaluate teacher knowledge growth.

Content knowledge
- **Positive Evidence**: - Most teachers claimed that they learned much more about app creation;
- **Opportunity to improve**: - Some teachers found inquiry-based learning approach less helpful in acquiring content knowledge; - Engage teachers with low prior CSDL knowledge; - Help teachers retain the knowledge.

Pedagogical content knowledge
- **Positive Evidence**: - PD exposed teachers with research findings, solidifying and challenging their thinking on how to teach CSDL; - PD introduced new pedagogy of teaching CSDL (e.g., pair programming); - PD provided the opportunity for co-designing curriculum;
- **Opportunity to improve**: - Introduce basic troubleshooting skills.

Collaboration and community
- **Positive Evidence**: - PD prompted ideas and allowed teachers to expand their teaching ideas and challenge themselves；- Teachers saw the power of collaboration between content area and tech teachers;
- **Opportunity to improve**: - Organize small group meetings within the same school district; - Better escalate teachers' needs to school district administrations.

Self-identification
- **Positive Evidence**: - Teachers were able to better recognize their own roles and values in implementing the CSDL curriculum.

Conclusion and Future

- The major contribution of this study is that the quantitative method used to analyze teachers' end-of-year survey goes beyond t-test to explore the correlations among variables that indicate teachers' self-efficacy patterns;
- The analysis of teacher interview sheds lights on their perspectives of how PD help can build their self-efficacy in teaching CSDL curriculum. The teachers' feedbacks were organized into five constructs that PDs can continuously focus on to build teachers' self-efficacy;
- The future study can further investigate whether or not content area teachers and CS/Tech teachers perceive their self-efficacy differently.

References:

Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures.Educational researcher, 38(3), 181-199.

Menekse, M. (2015). Computer science teacher professional development in the United States: a review of studies published between 2004 and 2014. Computer Science Education, 25(4), 325-350.

Skaalvik, E.M., & Skaalvik, S. (2016). Teacher stress and teacher self-efficacy as predictors of engagement, emotional exhaustion, and motivation to leave the teaching profession. Creative Education, 7(13), 1785-1799.

Zhou, N., Nguyen, H., Fischer, C., Richardson, D., & Warschauer, M. (2020). High School Teachers' Self-efficacy in Teaching Computer Science. ACM Transactions on Computing Education (TOCE), 20(3), 1-18.