Investigating Computational Thinking Self-Efficacy Beliefs of Pre-Service Elementary Teachers

Mr. Erdogan Kaya, University of Nevada, Las Vegas

Kaya is a PhD student in science education at University of Nevada, Las Vegas. He is working as a research assistant and teaching science methods courses. Prior to beginning the PhD program, he received his MS degree in computer science and engineering and holds a BS degree in chemical engineering. He taught K-12 STEM+CS for seven years. Additionally, he coached robotics teams and was awarded several grants that promote Science, Technology, Engineering, and Mathematics (STEM) and Computer Science(CS) education. He is also interested in improving STEM+CS education for minorities. He has been volunteering in many education outreach programs including Science Fair and Robotics programs such as First Robotics competitions. Areas of research interest include engineering education, STEM+CS, and robotics in K-12 education. Kaya advocates his view that research, teaching and learning are best practiced as a unified enterprise that benefits students and society. He has received numerous teaching awards as well as grants for his research from several foundations. Kaya is an active member of AERA, ASEE, ASTE, NARST, NSTA, and CSTA, has presented at over 15 conferences, published in ranked journals (e.g. Journal of College Science Teaching), reviewed conference proposals (e.g ASEE).

Miss Ezgi Yesilyurt, University of Nevada, Las Vegas

Ezgi Yesilyurt is a PhD student in curriculum and instruction/science education at University of Nevada, Las Vegas. She is working as a graduate assistant in an NSF funded grant project in which she assumed major responsibilities such as data collection, data analysis, design and delivery of teacher professional development workshops in the grant project. Also, she is currently teaching science methods courses. She received her MS degree and BS degree in elementary science education. She participated European Union Projects in which she conducted series of professional development programs for in-service science teachers. Areas of research interest are engineering education, inquiry learning, and evolution education.

Mrs. Anna Danielle Newley,

Anna Newley received a B.A. degree in Elementary Education from Arizona State University. She was an employee with the Tempe Elementary School District as a kindergarten, and second grade teacher, and instructional assistant until 2012. From 2012 to the current, she has been employed with the Sonoran Schools District. Presently, at Sonoran Science Academy-Phoenix, she is a fifth grade teacher. She is the contact for several grants awarded to the school. Mrs. Newley coaches the exploratory robotics club for grades 5-8, the Elementary Science Olympiad team, and the competitive high school robotics team, FTC. She contributed to international published papers, national proceedings, and is the process of writing several children’s books. This summer she will present a workshop on robotics for elementary school students.

Dr. Hasan Deniz, University of Nevada Las Vegas

Hasan Deniz is an Associate Professor of Science Education at University of Nevada Las Vegas. He teaches undergraduate, masters, and doctoral level courses in science education program at University of Nevada Las Vegas. His research agenda includes epistemological beliefs in science and evolution education. He is recently engaged in professional development activities supported by several grants targeting to increase elementary teachers’ knowledge and skills to integrate science, language arts, and engineering education within the context of Next Generation Science Standards.
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Abstract:
Self-efficacy beliefs of teachers is a significant identifier of teachers’ performance and motivation in teaching the specific content successfully; however, K-12 science teachers’ computational thinking self-efficacy beliefs are rarely discussed. Additionally, providing professional development opportunities or modifying current science teaching methods courses play a crucial role in improving teachers’ self-efficacy beliefs. With the release of Next Generation Science Standards (NGSS), assessing K-12 science teachers’ self-efficacy beliefs in computational thinking is an important research gap to study. This paper reports:
- the impact of the intervention on self-efficacy beliefs of pre-service elementary science teachers (PST).
- the significant change in computational thinking personal computational thinking teaching efficacy beliefs.
- no significant change is observed in computational thinking teaching outcome expectancy.

Introduction:
Self-Efficacy:
- “beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainment.” (Bandura, 1997, p.3)
Outcome expectancy is related to beliefs of teachers about their effects as a result of their teaching.
Personal Teaching Efficacy is about teachers’ confidence on their capability to teach the particular concept.

Computational Thinking (CT):
Definition of CT (Figure 1) relevant for K-12 science education can be summarized as:
- solving problems,
- designing systems,
- understanding human behavior, by drawing on the concepts fundamental to computer science.” (Wing, 2006).
It is a thought process in problem solving that uses the computer science principles, but is applicable to all other disciplines (e.g., science and engineering) (Kaya et al., 2018; Newley et al., 2018; Yadav et al., 2017).

Methods:
Research Question
To what extent will pre-service elementary science teachers’ computational thinking teaching efficacy beliefs change after engagement in the basics of coding, building educational robotics, and playing video games as part of an undergraduate level science teaching methods course?

Participants
- 21 pre-service elementary teachers (Female=11, Male=10) who enrolled in an undergraduate level course entitled “Elementary Science Teaching methods” during 2018 spring semester.
- 21 to 49 years age range, with a mean age of 26 years.
- Teachers did not have prior experience in programming, educational robotics and video games.

Intervention
- Introduction to computational thinking aspects coupled with relevant computational thinking readings (e.g., Yadav et al., 2017).
- Engagement in Educational Robotics Challenges (Figure 3)
- Programming in code.org environment
- Solving Zoombinis video game puzzles

Data Collection and Analysis
Data Sources
- Pre-and Post-assessments
- Replaced “science” with “computational thinking” Data Analysis
- SPSS Statistics 24.0 for MAC
- Analysis of pre- and post-assessment based on paired sample t-test (Table 1).
We assessed two sub-scales of Computational Thinking Teaching Efficacy Beliefs (CTTEB):
- Personal Computational Thinking Teaching Efficacy Beliefs (PCTTE)
- Computational Thinking Teaching Outcome Expectancy (CTTOE), to investigate if there is a significant difference in CTTEB prior and at the end of the course training.

Charts:

<table>
<thead>
<tr>
<th>Table 1. PST’s CT Self-Efficacy Beliefs</th>
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<tbody>
<tr>
<td>PCTTE (t=5.327, p &lt; 0.05) significantly improved</td>
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<tr>
<td>No significant improvement in CTTOE</td>
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- Introduction to CT instruction is fundamental in elementary science courses with adoption of NGSS.
- Significant increase in PCTTE, however, CTTOE beliefs did not improve.
- PST feel more confident to teach CT.
- PST improved their CT knowledge and understanding.
- For future studies, we are planning to integrate same CT instruction and apply the same assessment with higher sample size to run more valid statistical tests in elementary science teaching methods courses.
- We will investigate unique ways to improve outcome expectancy.

References:

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