An Investigation of How Professional Development Programs and Other External Factors Affect Changes in Teachers' Self-efficacy in Teaching Technology

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Abstract

Teachers' self-efficacy in teaching technology plays a key role in their teaching behavior. Teachers with higher self-efficacy tend to have a higher comfort level and confidence in using technology and even teaching technology in their classrooms. Studies have shown the correlation between teachers' self-efficacy beliefs with students' motivation and performance. Thus, understanding the factors that affect the change of efficacy is important. In this research, 11 high school physics teachers were recruited. They were participants in the Bootstrap Physics Modeling Workshop that was held at the Columbia Secondary School for Mathematics, Science and Engineering at 423 West 123rd St. in New York, NY by a non-profit organization, STEMteachersNYC, from August 1st, 2016 to August 19th, 2016. Conducted by the Bootstrap Program leaders from Brown University as well as teacher leaders from AMTA, the workshop aimed to combine the teaching of physics with a newly-developed computer language, "Pryet." A Likert-type survey was administered to define the levels of teaching self-efficacy in coding and teaching coding. Formal interviews of each individual participant were conducted at the end of the workshop. The quantitative and qualitative data collected indicated that: (1) participants' self-efficacy levels increased after the three-week workshop, (2) external factors, such as prior experience in coding and the sense of community, showed different extents of affecting the change of efficacy.

An Investigation of How Professional Development Programs and Other External Factors Affect Changes in Teachers' Self-efficacy in Teaching Technology

The purpose of this research is to investigate factors that affect teachers' self-efficacy in teaching technology. In recent years, educational researchers have demonstrated interests in studying how technological self-efficacy plays a role in teaching. The term self-efficacy is defined by Albert Bandura (1977) as a belief in one's ability to achieve certain level of goals or tasks. Studies further elaborate on Bandura's theory of self-efficacy by drawing strong correlation between teachers' self-efficacy and student performance, especially in a computer science class where teachers who acknowledge themselves as masters and facilitators of the class tend to meet their expectations of student achievements such as motivation (Gile & Kent, 2016). Additionally, teachers' efficacy levels also correlate with the amount of effort teachers intend to put into teaching and the characteristics of persistence and resilience teachers show in facing students with difficulties in learning (Hoy & Spero, 2005).

The critical role of strong self-efficacy belief in teaching behavior inspires researchers to investigate the different antecedents of such belief and the factors that have powerful influence on it. According to Tschannen-Moran, M., & Hoy (2007), verbal persuasion, mastery experience and school context are the main sources of teachers' self-efficacy with the mastery experience being the most powerful source (Bandura, 1997). When the mastery experience does not play a key role, novice teachers, compared to career teachers, are more pliable to change in efficacy due to contextual factors such as verbal persuasion and the availability of resources

(Tschannen-Moran & Hoy, 2007; Giles & Kent, 2016; Hoy & Spero, 2005). Besides, Watson's six-year study (2006) shows evidence of the long-term effects in teachers' efficacy after professional development programs: teacher self-efficacy level increases after the workshop and remains high after the program. Watson also acknowledges that certain external factors affect teacher self-efficacy level. Similarly, Mayo and Tanguma's three year study (2005) evinces that teachers with professional training program experiences obtain high levels of self-efficacy in teaching technology are more comfortable, more confident and more frequent in using technology than alternative certification teachers do.

In order to define the level of self-efficacy, researchers have developed different ways of measuring it. Gibson and Dembo's Teacher Efficacy scale to assess general teaching efficacy (GTE) and personal teaching efficacy (PTE), Bandura's Teacher self-efficacy scale and OSU Teaching Confidence Scale are four traditional measures that are proven to be reliable though small differences among them exist (Hoy & Spero, 2005). Dellinger, Bobbett, Olivier and Ellett (2008) introduced a brand new measure of teachers' self-efficacy beliefs, the Teachers' Efficacy Beliefs System- Self Form (TEBS-Self) which provides a contextual specific measure of teacher self-efficacy.

Based on the information gathered from previous findings**,** possible factors in this research that affect teachers' self efficacy in teaching technology - more specifically, teaching coding and integrating coding into future classes - are prior experiences with computers and professional development programs.

Method

Participants

In this research, 11 high school physics teachers were recruited. They were participants of the Bootstrap Physics Modeling workshop that was held at the Columbia Secondary School for Mathematics, Science and Engineering at 423 West 123rd St. in New York, NY by a non-profit organization STEMteachersNYC from August 1st, 2016 to August 19th, 2016. Conducting by the Bootstrap Program leaders from Brown University as well as teacher leaders from AMTA, the workshop aimed to combine physics teaching with a newly-developed computer language Pryet. All these physics teachers had experiences with modeling instructions, a teaching method that integrates the using of models and whiteboards into classrooms. Among the 11 participants, 2 of them were female and 10 of them were male. Their teaching years ranged from 2 years to 30 years with a mean of 12 years. All of teachers had master's degrees or higher in one science subject. Their different teaching experiences as well as different past experiences with coding made them good candidates for this research which targeted to find variables that affect teachers' self efficacy in teaching coding and integrating coding in physics. All the 11 participants agreed to be subjects of this research and completed surveys and interviews for research purposes.

Apparatus and Materials

Data collection methods included field notes and video recording of the workshop. Recording devices were used for video recording and individual interviews. Field notes, transcriptions of the interviews and a self-efficacy survey that measured self-reported efficacy in teaching computational thinking with coding and integrating coding into future physics classrooms were the main sources of the data.

Procedure

The study was designed to observe how teachers' self-efficacy in coding and integrating coding into their future classes change during the Bootstrap Physics Modeling workshop and find what essential factors affected the changes. The workshop was recorded by videos from the beginning to the end. Field notes recorded what happened at the workshop everyday with specific details about time and activities. A Likert-type survey that asked participants to rate the given statements from strongly agree, agree, neutral, disagree to strongly disagree on self-efficacy levels in coding, teaching computational thinking, and integrating technology in future physics classrooms was administered during the 1st day and the last day of the workshop. Formal interviews were conducted at the end of the workshop and each individual interview could last about 20 minutes. All transcribed interviews, video records, field notes taken during the workshop and collected data from the survey were utilized to answer the research questions.

Results

The results from the survey are collected and t-tests were given to measure the strength of differences between pre and post data. The numbers in the tables below indicate the strength participants' agreement to the corresponding survey questions: 1 indicates strongly agree and 5 indicates strongly disagree. There is a general trend of slight increase in the the levels of confidence from question 1 to 6 and question 7. Only responses to question 7 show decrease in the strength agreement. Also, the results suggest that the difference between the pre group and post group is not statistically significant except for responses to survey question 2, which the most increase in strength of agreement is demonstrated. T-test fails to compute the difference in between pairs in responses to survey question 8 due to all participants reported 1 (strongly agree)

both before and after. Overall, the data support the claim that participants' self-efficacy levels increase after the three-week workshop.

Table 1. Responses to survey question 1

Group	Q1: Pre	Q1: Post
Mean	1.45	1.18
SD	0.69	0.40
SEM	0.21	0.12
N	11	11

Table 2. Responses to survey question 2

Group	Q2: Pre	Q2: Post
Mean	2.09	1.18
SD	0.70	0.40
SEM	0.21	0.12
N	11	11

Table 3. Responses to survey question 3

Group	Q3: Pre	Q3: Post
Mean	1.36	1.18
SD	0.67	0.40
SEM	0.20	0.12
N	11	11

Table 4. Responses to survey question 4

Group	Q4: Pre	Q4: Post
Mean	1.36	1.18
SD	0.67	0.40
SEM	0.20	0.12
N	11	11

Table 5. Responses to survey question 5

Group	Q5: Pre	Q5: Post
Mean	1.64	1.27
SD	0.92	0.47
SEM	0.28	0.14
N	11	11

Table 6. Responses to survey question 6

Group	Q6: Pre	Q6: Post
Mean	1.82	1.45
SD	0.75	0.52
SEM	0.23	0.16
N	11	11

Table 7. Responses to survey question 7

Group	Q7: Pre	Q7: Post
Mean	4.00	4.09
SD	1.34	0.94
SEM	0.40	0.28
N	11	11

Discussion

a. Analysis of data collected from interview questions

During the three-week workshop, most of the teacher participants report positive feedbacks about their self-efficacy in teaching coding and integrating coding into their own classrooms. The data collect show that whether teachers have prior experience with programming or not does not appear to be a huge influential factor in the trend of increasing in efficacy. One of the teachers who didn't have much experience with coding answered to one of the interview questions, "*My confidence in coding is getting better. And then the more I learn, the more I realize I need to learn. It's just awareness. There is so much to learn. It's always evolving.*"

Similarly, one of the teachers who has been exposed to coding prior to the workshop said, *"I think it's going to be very useful. I am planing to use the units we wrote here. I am going to have to do more work on some of the units. I am really looking forward to trying it, especially the unit I wrote."*

Not only teacher participants feel more confident about the knowledge, but also they feel more comfortable and confident in implementing this method into their own future classrooms after the workshop. However, most of the teachers are not sure about to what extent they are going to incorporate this brand new teaching method to their own classroom. The following answers are collected.

"To what extent, I haven't fully decided yet."

"I am going to use them in an introductory physics course that I teach. I have a little bit of flexibility there. ...I am not sure to what extent. We will see how it goes."

Besides the possible factors, prior experiences with computer and professional developmental program, expected from the hypothesis, a new factor is found to be influential to the change of efficacy: the sense of community. During the first week of workshop, participants are not familiar with each other and there are disturbances caused by two completely different pedagogical approach, one focusing on teaching coding and the other focusing on physics contents, that the professors from Brown University and teacher participants have. The disturbances are reduced when both groups constantly communicate and reach a shared goal of the workshop as the workshop progresses. In this way, a new community of computer experts and teacher participants is created. One teacher participant mentioned the following at the end of the workshop, *"And we have a new community now. I forgot to mention that just now. I tried to*

teach programing to the 4th graders, but when I had difficulties in getting them to understand, I have no one to ask. Now I have a community." The direct feedbacks from the community members greatly encourage the teacher participant and enhance his/her confidence levels in teaching coding after he/she understands it. In fact, there is also a online discussion board for the participants and workshop leaders and monthly in-person workshops offered. It is in the sense of community that teachers generously share their experiences, consult with each other, benefit from each other and have a higher confidence in using the instrument.

b. Analysis of the survey

The survey results suggest that there is a slight increase in the participants' levels of confidence and comfortability in teaching science with programming and implementing the novel teaching method into their classrooms. The most notable change is shown in the responses to survey question 2, which states "I feel confident that the computer will help students understand concepts better". Participants also report positive change in levels of confidence in selecting appropriate software for themselves and their student, using the Internet in their lessons, using email to communicate, designing technology-enhanced learning activities, though the change is not statistically significant. The drop in the strength of agreement to survey question 7, which states " If something goes wrong, I will not know what to do to fix it", makes sense because participants' enhanced expertise in using technology after the three-week workshop will equip them with abilities to solve problems on their own. In the study, professional development program is one of the variable that accounts for the change in the levels of self-efficacy in teaching physics with coding since participants answer the survey

before and after the professional development program. However, there is no direct support for prior experience of computer science accounting for the increase in teachers' self-efficacy level. Additionally, it is also necessary to mention that one of the most major weakness of the survey method is its results derive from self-report data, which include the possibility of intentional deception.

c. Limitation and future suggestions

In the research, only one group of participants was recruited. The results of such are limited since the sample size is not large enough. For future researches, it is desirable that there would be a larger sample size. In the future, more researches could be done on the topic of other various factors that could affect changes in teachers' self-efficacy levels in integrating technology into their classrooms. For example, is the influence of extrinsic factors such as professional developments and different teaching environments more significant than the influence of intrinsic factors such as characteristics and prior experiences on changes of teachers' technological self-efficacy levels? Or does personal belief on the value of technology matter in the changes? These challenges await to be solved in the future.

Annotated Bibliography

1.

Giles, R. M., & Kent, A. M. (2016). An Investigation of Preservice Teachers' Self-Efficacy for Teaching with Technology. *Asian Education Studies*, *1*(1), 32. Retrieved from **http://journal.julypress.com/index.php/aes/article/download/19/49**

Giles and Kent's study focuses on defining self-efficacy and investigating the level of self-efficacy in teaching with technology in preservice teachers. They find a strong correlation between teacher self-efficacy and student performance, especially in a computer science class where teachers who acknowledge themselves as masters and facilitators of the class tend to meet their expectations of student outcomes. In this study, twenty-eight elementary preservice teachers from a single university are asked to complete a 5-item survey on a 6-point scale at the ends of both semesters' course. Numerical data of the survey show that preservice teachers in this study obtain a relatively high rate of their technological self-efficacy. Giles and Kent further conclude the necessity of integrating technology into preservice education programs and equip the preservice teachers with efficacy and comfortability in teaching with technology before they enter the field because efficacy of inservice or experienced teachers is resistant to

change. This is a helpful source in getting a general idea of what teaching efficacy is and the importance of it in preservice teachers.

2.

Tschannen-Moran, M., & Hoy, A. W. (2007). The differential antecedents of self-efficacy beliefs of novice and experienced teachers. *Teaching and teacher Education, 23*(6), 944-956. Retrieved from http://www.sciencedirect.com/science/article/pii/S0742051X06000953

Tschannen-Moran and Hoy highlight the sources of self-efficacy in novice and career teachers in their study. Referring to work by prominent psychologist Bandura, the authors mainly investigate the effects of verbal persuasion, mastery experience and school context on novice or experienced teachers' judgements about their teaching capabilities. They employ the method of survey that includes the Teachers' Sense of Efficacy Scale (TSES) on the 255 novice and career teachers who teacher volunteers or graduate students at three state universities. The survey consists of 24 items with a 9-point scale. The 24 items can be further divided into 3 subshells of efficacy for instructional studies, classroom management and student engagement. In addition, correlational analyses and multiple analysis were conducted to present the antecedents of teacher efficacy and the impact of various sources on novice and experienced teachers. The authors conclude that novice teachers, compared to career teachers, are more pliable to contextual factors such as verbal persuasion and the availability of resources and to change in efficacy when the mastery experience does not play a key role. This is a useful source for understanding

where self-efficacy of novice and experienced teachers comes from and the effect of these sources.

3.

Schiefele, U., & Schaffner, E. (2015). Teacher interests, mastery goals, and self-efficacy as predictors of instructional practices and student motivation. *Contemporary Educational Psychology, 42*, 159-171. Retrieved from http://dx.doi.org/10.1016/j.tate.2006.05.003

The authors study how teacher interest, mastery goal for the class and self-efficacy predict student motivation as an outcome and teacher mastery-oriented instructional practices. In the beginning of the journal, The authors discuss previous research and the reliability of using student reports and teacher reports to assess instructional practices that include mastery-oriented and cognitively activating practices. The methodology they use is questionnaire for both students and teachers on the topic of subject interest, mastery goals, educational interests and so on. 110 elementary teachers in Germany participate this study with their students. Their finding suggests that teacher motivation that comes from didactic interest and self-efficacy contribute mostly to the mastery-oriented instructional practices and thus student motivation. This is a good source for its statistical support of the correlation between teacher self-efficacy and student motivation.

4.

Hoy, A. W., & Spero, R. B. (2005). Changes in teacher efficacy during the early years of

teaching: A comparison of four measures. *Teaching and teacher education, 21*(4), 343-356. Retrieved from http://www.sciencedirect.com/science/article/pii/S0742051X05000193

The goal of this study is to examine changes in teacher efficacy from preservice period to first year of teaching by using Gibson and Dembo's Teacher Efficacy scale to assess general teaching efficacy (GTE) and personal teaching efficacy (PTE), Bandura's Teacher self-efficacy scale and OSU Teaching Confidence Scale. The authors analyze the data collected and conclude that efficacy increases significantly during student teaching and efficacy decreases during the first year of teaching. They also find a correlation between self-efficacy level the first year of teaching and the amount of support received. This is a good source for understanding the pattern of change during early years of teaching and the differences among four measures of teaching efficacy.

5.

Dellinger, A. B., Bobbett, J. J., Olivier, D. F., & Ellett, C. D. (2008). Measuring teachers' self-efficacy beliefs: Development and use of the TEBS-Self. *Teaching and Teacher Education, 24*(3), 751-766. Retrieved from http://www.sciencedirect.com/science/article/pii/S0742051X07000339

The paper introduces a new measurement of teacher's self-efficacy called the Teachers' Efficacy Beliefs System-Self Form (TEBS-Self). In the background section, the authors provide evidence from previous study to distinguish teacher self-efficacy and teacher

efficacy and suggest that these two beliefs should be measured differently. The development of this method is designed to provide a contextual specific measure of teacher self-efficacy instead of teacher efficacy which appears to be a general belief of ability to affect student performance without the setting of specific situation or tasks. The authors further prove the reliability and effectiveness of the TEBS-Self by applying it in three independent studies. The results of the studies suggest that the new measure worths more explorations.

6.

Milner, H. R., & Hoy, A. W. (2003). A case study of an African American teacher's self-efficacy,

stereotype threat, and persistence. *Teaching and teacher Education, 19*(2), 263-276. Retrieved from

http://anitawoolfolkhoy.com/pdfs/tate-revised.pdf

The qualitative investigation is designed to understand the sources of self-efficacy for Dr. Wilson, an African American teacher is a suburban high school. She identifies herself as a passionate and experienced teacher, however, her sense of efficacy was challenged at the beginning of her teaching experience at Ritz High due to the isolation and avoidance created by her colleagues. As a minority teacher, she recognizes her task and adopt the responsibility of demystifying the picture of a real African American solely to her students as well as her colleagues in her school. The mastery of the her goal means to invalidate stereotype about African Americans, which sounds impossible. It is the respect

from students and parents and her remembering of the intellect and persistency she has in her credentials that directs her to continue work on mastering her goal instead of easily leaving the unfavorable environment. The contextual and cultural specific case study provides sources of self-efficacy that corresponds to Bandura's theory and inspires orientation of future researches.

7.

Paraskeva, F., Bouta, H., & Papagianni, A. (2008). Individual characteristics and computer self-efficacy in secondary education teachers to integrate technology in educational practice. *Computers & Education, 50*(3), 1084-1091. Retrieved from http://www.sciencedirect.com/science/article/pii/S0360131506001643

The author clearly defines self-efficacy, self-esteem and computer self-efficacy in this paper. His study examines the relationship between individual factors (self-esteem, prior experience in computer science) of secondary school teachers and computer self-efficacy. 286 secondary school teachers in Greece participate in a demographic and self-evaluation questionnaires on general self-efficacy (GSE) and computer self-efficacy (CSE) as well as their previous skills and attitudes toward computer using. The results indicate that teachers who has high computer self-efficacy are likely to have high sense of general self-efficacy and desire to use technology as a teaching tool. This paper is a good source for understanding the correlation between the individual characteristics of secondary education teachers and their computer self-efficacy.

8.

Watson, G. (2006). Technology professional development: Long-term effects on teacher self-efficacy. *Journal of Technology and Teacher Education, 14*(1), 151. Retrieved from http://mds.marshall.edu/cgi/viewcontent.cgi?article=1001&context=eft_faculty

The paper investigates whether technology professional development affects the long-term self-efficacy of inservice teachers or not. The subjects are 389 teachers in the NSF funded K-12 RuralNet Project that trains inservice teacher on integrating computer into their math and science class. The teachers take surveys during pre and post workshops. They also complete a survey six years after the workshop. The results indicate that teacher self-efficacy level increases after the workshop and remains high after the program and certain external factors also affect teacher self-efficacy level. This is a helpful source for pointing out that professional development programs that help teachers prepare to use Internet as a teaching tool are one of the antecedents of teacher self-efficacy.

9.

Albion, P. (1999). Self-efficacy beliefs as an indicator of teachers' preparedness for teaching with technology. In Proceedings of the 10th International Conference of the Society for Information Technology & Teacher Education (SITE 1999) (pp. 1602-1608). *Association for the Advancement of Computing in Education (AACE)*. Retrieved from https://eprints.usq.edu.au/6973/1/Albion_SITE_1999_AV.pdf

The paper demonstrates that self-efficacy beliefs are a strong factor in assessing teacher's future success in integrating technology into their classes. The author reviews previous findings to support the importance of teachers' beliefs and the definition and sources of self-efficacy beliefs as well as instruments to measure it. Combined previous researches suggest that teacher self-efficacy beliefs about using technology are directly related to their technology instructional practices. This is a good source for its reviews and discussion of other findings.

10.

Mayo, N. B., Kajs, L. T., & Tanguma, J. (2005). Longitudinal study of technology training to prepare future teachers. *Educational Research Quarterly, 29*(1), 3. Retrieved from **http://files.eric.ed.gov/fulltext/EJ718118.pdf**

The three year study examines participants in a program that trains teachers to integrate technology into their classes. They evaluate the comfort level with technology, frequency of using technology and efficacy level of teacher candidates. The participants complete an eleven-item survey with a 5-point scale on these three variables. A follow-up study is conducted three years after the program. The frequency of technology use in classroom of the participants show that teacher candidates with professional training program are more comfortable, more confident and more frequent in using technology than alternative certification teachers do.

Appendix A

Interview questions:

Could you give an example on how computational thinking can be integrated into physics learning through programing?

How does your confidence in coding change over time since this summer? Why?

How does your confidence in integrating coding to physics teaching change over time? Why?

What factors have influenced your confidence?

What do you want to get more from the future workshops?

Appendix B

Survey statements:

1. I feel confident that I can select appropriate software to use in my teaching.
2. I feel confident that the computer will help students understand concepts better.
3. I feel confident that I can use the Internet in my lessons to meet certain learning goals.
4. I feel confident that I can use email to communicate with my students.
5. I feel confident that I can design technology-enhanced learning activities for my students.
6. I feel confident that I can teach my students to select appropriate software to use in their projects.
7. If something goes wrong I will not know what to do to fix it.
8. I feel comfortable with the idea of the computer as a tool in teaching and learning.

(Strongly disagree, disagree, agree, strongly agree)