Enhancing Teacher Efficacy for Urban STEM Teachers Facing Challenges to Their Teaching

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ABSTRACT: This paper explores challenges of teaching in relation to teachers' efficacy for 49 teachers who were part of a year-long teacher development program (PD) called the UrbanSTEM program. This program took place in an urban school district that serves over 300,000 students. This research asked if there are common challenges that urban teachers face when teaching STEM content. If so, do these challenges influence efficacy of teachers, and did the teachers' efficacy change over time due to their involvement in the UrbanSTEM program? Teachers identified external challenges, lack of resources, and organizational contexts having effect on their capacity to address the needs of their diverse students. Although the study did not identify significant relationship between challenges and efficacy, the study did show that this PD was successful in supporting urban STEM teachers by significantly increasing their self-efficacy.

Keywords: Teacher efficacy, personal teacher efficacy, urban teaching, teaching challenges, teacher professional development.

Communities of schools can be categorized generally as suburban, rural, or urban. These contexts have their similarities and differences. For example, while suburban classrooms are largely homogenous in terms of socioeconomic status (SES) and ethnic background, rural classrooms are predominately White (Chapman, 2007). In this study, the term urban is characterized as a school context that is "heavily populated with culturally and racially diverse learners and has a heavy concentration of English language learners, a large number of poorer students, particularly students of color, high attrition of teachers, heavy institutional and systemic barriers, and meager resources" (Milner, 2006, p. 346). Hence, urban school districts face various challenges when providing students' education, and this is especially true for students in Science, Technology, Engineering and Mathematics (STEM) courses where cultural, racial, economic, and gender divides are prominent (Chubin and DePass, 2014). Additionally, this study uses the word "challenges" to label any problematic factor that may affect the teaching and learning process in schools from the perspective of the urban teacher, specifically within the classroom setting.

This paper explores challenges of teaching in relation to teachers' efficacy for teachers who are part of a year-long teacher development program called the UrbanSTEM program. The UrbanSTEM program's goal is to equip and empower STEM (science, technology, engineering, & math) teachers (K-12) to create transformative and relevant learning experiences in urban classroom settings, in order to increase their teacher efficacy, creativity, and pedagogical toolkit. This paper focuses on teachers within this specific context because teachers' efficacy is context

specific (Goddard et al. 2000). Specifically, this study investigated: (a) if challenges persist in the urban school context, (b) how the potential challenges influence the efficacy of K-12 STEM teachers, and (c) if the teachers' efficacy is changed as a result of being in the UrbanSTEM teacher development program.

Context and Ideology of the UrbanSTEM Program

African Americans, Hispanic Americans, American Indians, Alaskan Natives, and Native Hawaiians only represent 9.1% of college-educated Americans in science and engineering occupations (NRC, 2011). The UrbanSTEM teacher development program seeks to counter this issue by focusing on the development of K-12 STEM teachers who teach in urban settings where many of their students are of underrepresented minority groups. The UrbanSTEM program focuses on teachers' abilities to creatively integrate technology into their pedagogies and fostering a sense of competence and community among educators which can make a great impact on student learning and engagement (Goldhaber, 2002; Harris & Sass, 2011), specifically in STEM disciplines.

Additionally, the organization of teacher professional development (PD) in schools and districts is shared and trivial (Desimone, 2009), especially in large urban school districts, where the PDs are brief workshops with unclear importance levels (Sykes, 1999). Such challenges allow for the UrbanSTEM PD program to take a unique approach to teacher PD. This program takes place in an urban school district that serves over 300,000 students. In an urban environment, teacher knowledge and skill sets are important because teachers play a crucial role in the lives of children and need to possess an eclectic array of skills and practices that are suitable to a diverse group of students (Lingam, 2010). However, educators' opportunities to learn new practices and skills are irregular, poorly designed, and shoddily presented (Danielson & McGreal, 2007; Hawley & Valli, 1999).

The UrbanSTEM teacher development program is built on the Technical and Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006) and the instructional approach uses the power of experience (Dewey, 1938) involving real world engagement with tools and pedagogies in STEM constructs. This retreats from the idea of simply reading and lecturing as the only modes of learning in school. Additionally, the program follows Dewey's idea that the educative experience should include humanizing the content, so that it is relatable to the learner, and empowering the learner by listening to and understanding what each learner brings to the classroom. An example of humanizing content may start with requiring a language arts high school class that has majority Black and Brown students to read novels that have characters of similar cultural and ethnic backgrounds, or conducting classroom activities that allow students to live the experience of the novel's characters through choice making scenarios. Learning concepts explained by Dewey are also consistent with the framework of culturally relevant teaching where teachers use students' individual strengths and cultural values as a bridge to learning, which is a common practice of successful teachers for students of color (Ladson-Billings, 1995).

Finally, the UrbanSTEM program endorses its most unique element into its PD ideology, which is the stimulation of creativity and wonder within the participating teachers. Seals, Horton, Berzina-Pitcher & Mishra (2016) discuss how the UrbanSTEM program nudges teachers into a culture of embracing failure, treating challenges as an opportunity to try a new approach, and to think outside of the box, especially for simple matters. The purpose of this ideology encourages teachers to have an eclectic approach to their classroom, where they know that one method can

not solve their students' learning problems, but that having multiple methods in their mental tool kits can allow them to be more effective as a teachers to all types of students[1].

Theoretical Framework: Teachers' Efficacy

The origin of teacher efficacy research comes from Bandura's (1977) social cognitive theory that explains human agency and behavior change and from Rotter's (1966) locus of control theory. Researchers on teacher efficacy "do not have a common agreement on how the construct should be conceptualized and measured," (Skaalvik & Skaalvik, 2010; p. 1059) due to the complicated, constant changing, and contextual dependence on what makes teaching and learning effective. The broad definition of teacher efficacy is described as the teacher's perception of his or her own ability to influence student learning and achievement (Ross, Cousins, & Gadalla, 1996; Tschannen-Moran & Hoy, 2001). The teacher efficacy scale (TES) that is used in this study has two constructs: *teacher efficacy* (TE) and *personal teacher efficacy* (PTE). Teaching efficacy is the teacher's belief that teaching is or is not a powerful factor for learning, and personal teacher efficacy is the belief that they (the teacher) can or cannot be effective in teaching their own students (Soodak, Podell, & Lehman, 1998; Tschannen-Moran & Hoy, 2001; Woolfolk & Hoy, 1990).

The influences on efficacy beliefs are based on the four sources of efficacy described originally by Bandura (1997) as (1) mastery of past experiences or previous success in the same or similar task, (2) physiological or emotional arousal felt from completing the task in the past, (3) vicarious experience or learned information about the task by watching others, and (4) verbal persuasion or what others tell you about the task and your ability to complete the task. These four sources of efficacy also apply to how teachers perceive their own efficacy and there have been studies that explore the various items that influence teachers' efficacy specifically (Tschannen-Moran, Hoy, & Hoy, 1998; Tschannen-Moran & Hoy; 2001; Bandura, 1986, 1997).

Skaalvik & Skaalvik (2010) conducted a study that explored the relationship of teachers' perceptions of school context, teacher self-efficacy, teacher burnout, job satisfaction, and teachers' beliefs that external factors influence their ability to teach effectively. By using correlations of structural equation modeling, they found that teacher self-efficacy was negatively related to teacher burnout (emotional exhaustion and depersonalization). Additionally, they found that relationships with parents was a strong predictor of teacher self-efficacy and the depersonalization dimension of burnout. Skaalvik & Skaalvik (2009) also stated that experiencing a lack of cooperation or lack of trust from parents may result in lowering teacher self-efficacy. They also found that time and pressure was the strongest predictor of the emotional exhaustion dimension of burnout and that job satisfaction was directly related to teacher self-efficacy. In summary, this study showed many aspects of teaching have an effect on teacher efficacy, especially relationships with parents and teacher burnout.

Goddard, Hoy, & Hoy (2000) also discuss the factors that influence a teacher's efficacy stating,

> In assessing (self-perceptions of teaching competence), the teacher judges personal capabilities such as skills, knowledge, strategies, or personality traits balanced against personal weaknesses or liabilities in this particular teaching context. The interaction of these two components leads to judgments about self-efficacy for the teaching task at hand. (p. 482)

This statement illustrates many elements that are considered when determining teacher's efficacy. Coupled with the findings from the Skaalvik & Skaalvik's (2009) study, we see a large

variation in challenges that can impact efficacy. Moreover, teacher's efficacy is context specific (Goddard et al., 2000), to the point that it could change from one class period to the next (Ross et al., 1996). This puts an emphasis on the need to study teachers' efficacy in specific contexts while teaching specific content. Hence, when making a "judgement" about teacher efficacy, the context and the content should be considered (Goddard et al., 2000, p. 482). This study aims to throw light on these two specific elements of teacher efficacy (the context (urban) and the content (STEM)) by looking at teaching and learning challenges that may influence the efficacy of urban teachers who teach STEM subjects and then measure if that efficacy changes as a result of participation in the UrbanSTEM program.

Method

The primary research questions that are addressed in this study are: (a) Are there challenges that teachers in urban contexts face when teaching STEM content? (b) If there are challenges, do the challenges impact the efficacy of teachers in urban contexts? and (c) In what ways does the UrbanSTEM program impact teacher efficacy over time?

Participants

This study includes 49 STEM teachers in a large urban school district who are enrolled in the second cohort of the UrbanSTEM program after applying and being selected based on their essay responses, letters of recommendation, leadership, and past teaching experience. Thirty-two (65%) of the teachers identified as female, 20 (41%) of the UrbanSTEM teachers identified as White, 12 (25%) African American, six (12%) Hispanic/Latino, five (10%) Asian. Also, 24 (49%) taught at the middle school level, 15 (31%) taught high school, six (12%) taught elementary, and four (8%) taught at the elementary and middle school level. Finally, 21 (43%) taught science, 19 (39%) taught math, six (12%) taught math & science, two (4%) taught technology, and one was strictly an administrator.

Measures & Procedure

In order to assess if the program meets its intended goal of empowering urban STEM teachers to create transformative and relevant learning experiences, the UrbanSTEM program's researchers assessed the participating teachers' levels of efficacy at three time points across the academic year.

The study consists of several procedural steps. First, the Teacher Efficacy Scale (TES) by Woolfolk & Hoy (1990) was administered to all 49 participant at three time points. The first time point was prior to the first meeting of the year (June). Six months later (December), the TES was administered for the second time, and five additional months later (May), the TES was administered to the teachers for the third and final time. The TES is a 22 item scale with all answers on a six-point Likert scale from strongly agree to strongly disagree. The items that made up the two constructs in this scale, TE and PTE, were mixed throughout the survey. The reliability of the TE construct was .813 and the reliability of the PTE construct was .855; however, the two constructs had a moderate factor to factor correlation of .468.

In order to obtain data about the challenges that urban teachers face, four open-ended questions from an online survey were distributed to the 49 teachers during that second time point (December) only. One of the questions asked the teachers to "briefly describe one or two major challenges that you face as a teacher at an urban school."

Data Analysis

The research team modified the Consensual Quality Research (CQR) method developed by Hill et al. (2005) and used it to analyze the open-ended question about challenges. Hill et al.

(2005) describe CQR as a constructivist data analysis approach that acknowledges that individual realities are socially constructed, and this method allowed the research team to learn about the teachers' teaching experiences through their own socially constructed realities. CQR is also influenced by phenomenology, grounded theory, and comprehensive process analysis. To foster multiple perspectives, three researchers independently read the response data and developed codes. Then through collaborative work, each code was discussed until consensus was built to arrive at the central ideas in the responses. Moreover, two of the researchers collapsed the codes into four common categories that each exclusively represented the types of urban related challenges that teachers were facing, therefore answering research question one. A senior researcher on the project served as auditor "to check the work of the primary team of judges and minimize the effects of groupthink in the primary team" (Hill et al., 2005, p. 3).

After finding the four challenges categories, a mixed ANOVA was conducted that used the four categories as between subjects factors to predict teachers' efficacy. Gender, race, level of school, and subject taught were used as covariates in the analysis with the three time points as the within subjects factor, which answered research question two. Finally, we used the results from the mixed ANOVA test to see if teachers' efficacy changed over the three time points to answer the final research question.

Results

The CQR method allowed the researchers to identify 17 major challenges (see **Table 1**) that teachers face while teaching STEM in an urban context (RQ1). Of the 49 teachers, 45 responded to open-ended question and responded to the TES at all three time points, so all of our data will be based on the 45 teachers. The list of 17 challenges that were identified by respondents were collapsed into four categories, including: (a) *student perception challenges* (n=13), such as how much the students value or prioritize school or content, perceptions of negative stereotypes, motivation, and views of self; (b) *family, home and community challenges* (n=8), such as a lack of support or parental involvement, finances, academic know how, family instability, and community violence; (c) *school and administration challenges* (n=16), including staff cuts, changes, mergers, and expectations from administration, lack of resources and policy restraints; and (d) *student diversity challenges* (n=8) that includes the varying backgrounds in skills, culture, and knowledge of the students. Teachers were placed in one of the four challenge categories based on the primary code from their response. If the teacher's primary code did not fit into the four major categories, they were placed in a category based on their secondary code, or third code if the second did not lead to a category. Please see **Table 2** for examples of quotations from the teachers that fit into the four challenges categories.

To determine if challenges impact the efficacy of teachers in urban contexts (RQ2), the four constructed challenge categories were used as condition groups for predicting efficacy in teachers. Findings from the mixed ANOVA show that there are no significant differences in challenge category in TE, teacher efficacy, $F(3, 41) = 1.89$, $p = 0.15$, nor in PTE, personal teacher efficacy, $F(3, 41) = 0.95$, $p = 0.43$. Additionally, there were no significant differences in TE nor PTE across any of the measured covariates (race, gender, school level, & subject taught). Findings concerning if the UrbanSTEM program impacts efficacy over time (RQ3), using an ANOVA, show that there are not significant changes over time in TE, $F = 0.42$, $p = 0.66$ (see **Figure 1**), but that there is significant change in PTE, $F = 16.47$, $p < .001$, $\square^2 = .23$, across the three time points (see **Figure 2**). Post hoc results for PTE over time show that there is a significant difference between time one PTE, 95% CI [4.08, 4.54] and time two PTE [4.28, 4.74]

and between time two PTE and time three PTE [4.60, 5.08]. See **Table 3** for descriptive statistics of efficacy across the four challenge conditions over the three time points.

In summary, the results of question one helped to identify the challenges that STEM teachers in urban settings face. However, these data do not show significant differences in a teacher's efficacy based on the four categorized challenges that the teachers were coded, deterring this study from making a strong connection between a teacher's perception of self competence and the challenges that they face in an urban school environment. Yet, the increase in the PTE construct over the year does infer that participation in the UrbanSTEM program is related to this change, which is a central finding to this study.

Discussion

The results of this study affirm some of the many challenges that are chronic to teaching and learning in urban school settings, like staffing schools (Jacob, 2007), the range in diversity of students needs (Zhou, 2003), and the importance of parental support (Jeynes, 2005). The findings from this study, however, do not contribute to the literature on teacher efficacy because the different types of challenges that teachers face in an urban setting did not predict statistically different efficacy scores in the teachers.

Considering limitations of this study, our data is based off of 45 participants. This is not a large participant pool, therefore hurting the effect size of this data. In a future study, having a larger number of participants could assist in finding variation among the four urban challenge predictor groups. Moreover, this group of teachers applied to the UrbanSTEM program and were chosen based off of their essay responses, letters of recommendation, interest in leadership, and by meeting the qualification of having at least three years of licensed certified classroom teaching experience. Though a diverse group of teachers was purposefully selected, this group represents a possibly highly motivated group of teachers and may not show much variation in efficacy levels because they most likely entered the program as confident and efficacious teachers.

The finding of research question three is central to this study because the PTE of teachers did significantly increase over their year of involvement in the UrbanSTEM program for all participants, but the TE of teachers did not significantly change. As previously described, PTE is the self belief that the teacher can be effective in teaching, while TE is the teacher's belief that teaching is a powerful factor for learning. This can be explained by the teaching and learning philosophies endorsed by the UrbanSTEM program. The UrbanSTEM program promotes hands-on learning, encouraging teachers to focus their lessons around the needs and understandings of the students, while creatively using various tools to enhance the teaching and learning experience. By expanding creative pedagogical lenses of teachers, the teachers are becoming more knowledged and empowered to tackle various challenges that they may face, thus explaining an increase in PTE. The UrbanSTEM program is also very sensitive to the environment and context that teachers are in and seeks to inspire pedagogical innovation despite potential shortcomings of their context. TE reflects the teachers' views on schooling as an institution and being effective in educating students despite environmental challenges. Messages from UrbanSTEM stimulate teacher ingenuity, therefore, increasing teacher beliefs in self and not so much increasing beliefs in the system of schooling/teaching.

The changes in PTE over time, though not significantly different, between the urban challenge groups, supports the importance of control when determining efficacy. When looking at the mean PTE of all four of the challenge groups, there is a larger increase in three of the four

condition groups (student perception, school and administration, and student diversity groups). However, there is only a slight growth, from time 1 to time 3, for the family and home group (see Table 3 and Figure 2). Compared to the other three group challenges, family and home challenges are the most external to the school, and therefore teachers have the least control over fixing them. For those teachers who primarily deal with students' family and home challenges, results were consistent with the idea that teachers' efficacy may not be consistent if they are dealing with items that they cannot control, such as students' family and home challenges. Table 3 and Figure 2 show that self perceptions of PTE are lower for teachers when students' family and home challenges are dominant. Moreover, the items that make up the TE construct are related to home challenges that teachers cannot control. An example of TE items includes, "The hours in my class have little influence on students compared to the influence of their home environment," or "If parents would do more for their children, I could do more." The TE construct shows that teachers awareness of items that they cannot control play a role in their TE growth over time, despite which challenge group they were placed in.

Implications and Conclusion

Considering the positive impact of the UrbanSTEM program on teachers' efficacy over a one year period, this paper gives suggestions to researchers and practitioners as to how a PD program could help teachers to increase in PTE (beliefs about their effectiveness as a teacher). However, the UrbanSTEM PD program does not seem to strengthen teachers' TE (beliefs concerning how effective general teaching is for students' learning when considering circumstances out of the teacher's control). Despite the impact of a PD, teachers still work within the context of their school and Tschannen-Moran and Hoy (2002) suggest that teachers make efficacy evaluations by considering the resources and constraints in their specific teaching contexts. This infers that teacher challenges do impact their efficacy, but a few previously mentioned limitations may have kept the findings of this study from supporting that stance. Additionally, this may have practical implications for a professional development program, encouraging that PD instructors design a PD that is very specific to the needs and challenges to the teachers within their context. The UrbanSTEM program does this by providing teachers with purposeful, flexible, and scaffolded real world engagement tools and pedagogies that teachers can use in their classrooms in the context of STEM education in an urban setting, and could serve as a blueprint for future STEM K-12 PD for urban schools.

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Table 1: Urban Challenges Coded from Teacher Responses

Urban challenges
1. Student value of and prioritization of school.
2. Stereotype threat & Self-fulfilling prophecy (concerning STEM).
3. Low student motivation, engagement, apathy (give up easily; over confident kids don't try hard).
4. Student view of self (low self esteem, fixed view of ability).
5. Student diversity (varying backgrounds in skills, culture, knowledge, etc.).

6. Family/home challenges: lack of support/love/finances (kids switching homes; parents can't do math or read well, hands off approach, no buy in).
7. Home/community violence (Safety).
8. Attendance, especially lack of.
9. Student low achievement (Lower reading skills).
10. Teacher motivation
11. Lack of classroom resources (funding materials, lab equipment, etc.).
12. Administrative organizational challenges: CPS staff cuts, changes, mergers, expectations from admin, policy makers restrain teaching, etc.
13. The "right" amount of homework (completing homework).
14. Student workload (involvement).
15. Managing responsibilities as a teacher: work life balance.
16. Classroom management (interruptions).
17. Hidden curriculum: Teacher duties outside of teaching (e.g., calling parents).

Table 2: Number of Teachers in Each Challenge Category

Challenge categories	N	Example quotes
Student perception	13	"Student motivation is the most significant issue that I face as a teacher." "Self-motivation in students. It's difficult at times for some students to independently remain committed to maintaining successful work habits." "Lack of care in students - No student motivation, Nothing is of interest; apathy."
Family, home and community	8	"When parents are not involved with their child's education for whatever the reason (work when their child is home, parent can't help with work because they can't read or they don't know how to do basic math)." "Lack of resources on the student end (no internet at home, lack of food/clothing)."

School and administration	16	"Administrative turnover: e.g., three different principals and APs in the past 3 years." "Teachers' creativity is limited by content and curriculum directives from administration. "Technology is not updated nor maintained..."
Student diversity	8	"Wide range of skills among students." "One of the biggest challenges I face as a teacher at an urban school is the diversity of my students." "I have students who have vastly different cultural and background experiences."

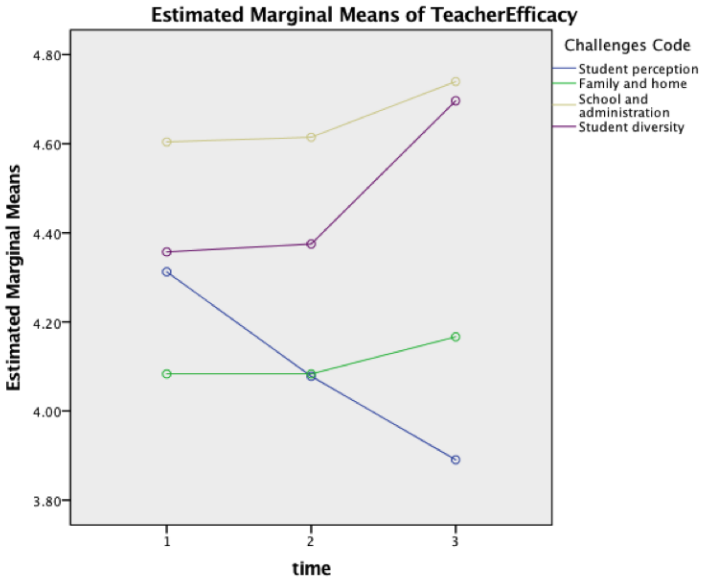
Note: Includes the number of teachers in each challenge/condition group and quotes from the responses of teachers when asked to describe challenges that they face in an urban school setting.

Table 3: Descriptives of Efficacy Across Teacher Challenge Category Over Time

Challenge Category	TE			PTE		
	T1	T2	T3	T1	T2	T3
Student perception n=13	4.40 (0.59)	4.21 (0.56)	3.89 (0.99)	4.38 (0.47)	4.63 (0.42)	4.84 (0.45)
Family, home and community n=8	4.11 (0.39)	4.06 (1.14)	4.17 (0.82)	4.25 (0.25)	4.30 (0.63)	4.51 (0.70)
School and administration n=16	4.70 (0.74)	4.67 (0.65)	4.77 (0.78)	4.41 (0.70)	4.65 (0.59)	5.03 (0.66)
Student diversity n=8	4.20 (0.97)	4.16 (0.93)	4.70 (0.64)	4.42 (0.64)	4.55 (0.86)	5.14 (0.37)

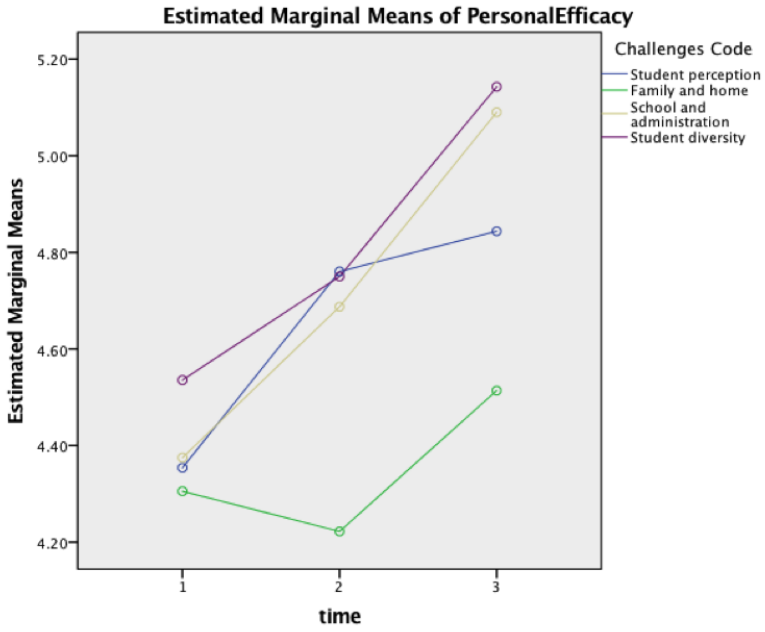
Note: Means and standard deviations reported for teacher efficacy and personal teacher efficacy over three time points (June, December, May).

Figure 1: Change in Teacher efficacy (TE) Over One Year



Note: Three time points represent June (1), December (2), and May (3). The estimated marginal means are the means for each group adjusted for the other variables (e.g., race, gender, etc.) in the model.

Figure 2: Change in Personal Teacher Efficacy (PTE) Over One Year



Note: Three time points represent June (1), December (2), and May (3). The estimated marginal means are the means for each group adjusted for the other variables (e.g., race, gender, etc.) in the model.