

An Analysis of Noyce Scholar Personal and Professional Self-Efficacy

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Abstract

This study examined themes of transition from pre-professional to professional status for six National Science Foundation Robert Noyce Scholars enrolled in a Master of Arts in Teaching in Secondary Education Program. An instrumental deductive coding framework was utilized to analyze study data pertaining to Scholar professional self-efficacy. Professional transition themes were observed to varying degrees in the pre and post essays for all the Noyce Scholars engaged in this study. Findings from this study included confirmation of the perception of professional growth among the Scholars, particularly themes pertaining to teacher self-confidence and professional knowledge. In addition to documenting the effects of the program on Scholars' perceptions, the study serves as a potential gateway to more extensive research on teacher self-efficacy of STEM preservice teacher development.

Keywords: STEM teacher professional development, self-efficacy, professional transition, preservice teachers, professional knowledge, teacher induction

1. Introduction

Since 2002, the National Science Foundation (NSF) Robert Noyce Scholarship Program has endeavored to address the shortage of qualified K-12 science, technology, engineering, and mathematics (STEM) educators teaching in underserved and underrepresented schools in the US. The Noyce Program has supported scholarship, mentorship and research programs directed at the recruitment, retention and education of the nation's preservice and in-service STEM teachers in high-need schools (National Science Foundation Authorization Act of 2002 (P.L. 107-368)).¹ The primary goal of the Noyce Program is to address the critical need for highly effective K-12 mathematics, science (including computer science) and engineering teachers. As part of Noyce program requirements, scholarship recipients (Scholars) must commit to teaching for two years as a STEM teacher in a high-need local educational agency (LEA) within 4 years of graduation or completion of the program for which the scholarship was awarded. The NSF Robert Noyce Scholarship Program at the university under study has attempted to address the shortage of STEM teachers through the development and implementation of a program that awards scholarships to qualified STEM majors and professionals enrolled in the Master of Arts in Teaching (MAT) in Secondary Education Program.

¹ The Noyce Program was reauthorized in 2007 under the America COMPETES Act (P.L. 110-69) and the America COMPETES Reauthorization Act of 2010 (P.L. 111-358), and amended by the STEM Education Act of 2015 (P.L. 114-59).

The program is fully integrated into the existing MAT in Secondary Education Program, which prepares preservice teachers to teach in grades 7-12 and includes a full-year internship (3 days/week in the fall and 5 days/week in the spring) and small cohort sizes. The primary goal of the program is to develop highly-qualified, reflective practitioners who have a deep sense of their personal and professional self-efficacy, extensive knowledge of their disciplinary subject matter and adept teaching skills and practices to effectively facilitate learning for students from diverse backgrounds, abilities and interests. The program emphasizes sociocultural and social constructivist theories of teaching and learning with a particular focus on models of inquiry, project-based, and problem-based learning.

Over the past 10 years, the Noyce Program has awarded 51 scholarships to STEM majors and professionals enrolled in the MAT Program. Most Noyce Scholars have completed MAT program requirements and secured licensure in a STEM teaching field. Currently, 40 teachers have met the required 2-year teaching obligation in a high-need district, ten teachers are currently working on their teaching obligation and one Scholar left the teaching profession soon after completion of the program.

As part of a longitudinal study of Noyce Scholar development and Scholar impact on student learning, we were interested in examining how Scholars' perceptions of their professional self-efficacy (Bandura, 1997) may have changed over time. We hypothesized that perceptions may have progressed from emphases mainly on their own personal qualities associated with their success prior to MAT program enrollment as compared to emphases on personal and professional qualities and dispositions of a STEM educator upon completion of the MAT program. In this study, we examined themes of transition from pre-professional to professional status for six Noyce Scholars enrolled in the MAT in Secondary Education Program. We were guided by the following research question: *To what extent did Noyce Scholars' professional self-efficacy change from pre to post MAT Program completion?*

2. Theoretical Framework

2.1 Teacher Self-Efficacy

The construct of self-efficacy denotes the confidence that individuals possess about their ability to successfully plan, organize and engage in tasks resulting in positive outcomes and actions over time. Bandura (1997) theorized that the outcome of an individual's self-efficacy has various effects on the actions they choose, the extent of effort, perseverance and resilience they exert, the kinds of thought patterns and coping mechanisms they cultivate, and the degrees of accomplishments they achieve. Bandura's theory of self-efficacy can be extended to include teachers as models for these kinds of constructive behaviors and actions for students. An organized and engaged teacher who consistently demonstrates high expectations and well-defined standards can anticipate that students will respond in kind with positive interactions, resolute effort and perseverance in the tasks that they engage in over time.

Researchers have found that teacher self-efficacy is related to the development of effective teaching and organizational practices. Teachers who tend to have high levels of self-efficacy are more inclined to integrate new strategies and methods into their teaching practice, be more efficient, organized and self-directed and often demonstrate professional attitudes of accomplishment and enthusiasm with themselves and their overall teaching practice. (Tschannen-Moran & Woolfolk Hoy, 2001; Bamberg, 1994).

Self-efficacy supports the ongoing professional development of preservice teachers. (Joyce, Hersh & McKibbin, 1983). In order to successfully assume the roles and responsibilities of a classroom teacher, preservice teachers need to be cognizant of their personal and professional self-efficacy (Ryell, Bernsauzen, & van Tassell, 2001). Researchers have also found that high levels of teacher self-efficacy appear to have a positive impact on overall student achievement (Guo, Piasta, Justice & Kaderavek, 2010; Woolfolk-Hoy, 2005; Shoulders & Krei, 2015). Other studies have reported on the impact of positive student teacher mentorship experiences on preservice teacher self-efficacy (Hamman, et.al., 2006).

2.2 Professional Transition

Over the past 10 years, a number of researchers have investigated aspects of professional transition of Noyce Scholars from preservice to in-service teachers. Whitfield's (2016) examination of Scholars' perceptions and decisions about teaching and the teaching profession found that Scholars' decisions to become teachers occurred at a younger age (before 18 years) than non-Noyce Scholars. In addition, factors such as flexibility or autonomy in the teaching profession did not appear to be a major influence on Scholars' decisions to become teachers.

A study of Scholars' perceptions of the impact of the Noyce scholarship on the decision to become a teacher revealed that receipt of the scholarship influenced both their commitment to completing the STEM licensure program as well their commitment to teaching in a high need school district (Liou, Kirchoff & Lawrenz, 2010).

A longitudinal research study (Bischoff, P., French, P. & Schaumloffel, J., 2017) that examined the progression of Noyce Scholars' self-view as STEM teachers over a three-year period identified five "broad emergent themes" (See Table 1.) that described how STEM teachers evolved from preservice to in-service teachers. These broad themes included: experience, challenges, career goals, satisfaction and confidence, and general teacher perspective. Results indicated that Scholars' self-view changed from a distinct focus on personal experiences as undergraduate students to a more comprehensive understanding of the challenges, responsibilities and professional knowledge and skills required by in-service teachers teaching in high need schools.

3. Methods

In our investigation of Scholars' professional self-efficacy and growth, we utilized an instrumental case study framework (Stake, 2000) where the researcher's purpose is predetermined and permits the selection of instruments and preliminary coding schemes prior to data collection. In an instrumental case study, the methods, meanings and patterns emerge after many repetitions of data collection, interpretation, and reflection.

Themes of professional transition (Bischoff, P., French, P. & Schaumloffel, J., 2017) served as a model for the conceptual and analytical framework for this study that examined changes in Noyce Scholar professional self-efficacy pre and post MAT program completion. Five "broad emergent themes" that described how STEM teachers evolved from preservice to in-service teachers were utilized in the coding and analytical phases of the study. These broad emergent themes are summarized in Table 1. below

Table 1. Five Broad Emergent Themes

Theme	Theme Descriptions
Experience	A statement specifically referring to a teaching or learning event in which the Scholar participated.
Challenges	A statement where the Noyce Scholar specifically describes a challenging situation.
Career Goals	An affirmative statement about becoming a teacher, a statement about where they plan on teaching, or a statement describing some other professional goal they wish to accomplish.
Satisfaction and Confidence	Statements describing a sense of satisfaction with their work or a sense of confidence in their ability to teach.
General Teacher's Perspective	Statements describing general teacher knowledge, relationships with students, classroom management or familiarity with content and pedagogy. (From: Bischoff, P., French, P. & Schaumloffel, J., 2017, pp.1222-1223)

3.1 Coding Strategies

A deductive coding strategy (Creswell, 2015; Yi, 2018) that utilized pre-identified themes or categories of description from the professional transition framework developed by Bischoff, French and Schaumloffel (2017) was employed in the analysis of project data. The coding process was first initiated by the development of a codebook or list of themes (e.g. *experience, challenges, goals, confidence and knowledge*) related to professional transitions. These codes were then utilized to interpret, categorize and compare pre and post essays. Through side-by-side comparisons, we coded for the presence or absence of the five professional transition themes in each of the narratives constructed by the Scholars and noted commonalities and apparent differences that were worthy of further investigation.

3.2 Study Participants

This study examined the changes in professional self-efficacy from pre to post program completion for 6 MAT students working towards teaching licensure in science or mathematics who were awarded the NSF Noyce Scholarship.

Eligibility for the Noyce scholarship required that applicants must have an undergraduate or graduate STEM degree, a minimum of a 3.0 GPA, a commitment to teaching in high need school districts, and be U.S. citizen or national, or permanent resident alien. The Scholars enrolled in a 31 credit year-long Master of Arts in Teaching in Secondary Education program. The program consisted of a full-year internship at a local high-need middle school or high school and a breadth of education coursework that included such topics as adolescent development, special education, curriculum, assessment, literacy integration, classroom management and STEM teaching methods.

All six Scholars are white, represent a range of ages and undergraduate and graduate STEM majors. To date, all of the Scholars have successfully completed the MAT program as well as state requirements for licensure in their respective subject areas and earned a Master of Arts in Secondary Education degree (MAT) upon completion of the program. Scholar demographics are summarized in Table 2. below.

Table 2. Noyce Scholar Characteristics

Scholar	Age at Graduation	Prior Degree	Major	Teaching License
S1	30	BS/MS	Mathematics	Grade 7-12 Mathematics
S2	30	BS	Environmental Science	Grade 7-12 Science
S3	26	BS	Civil Engineering	Grade 7-12 Science
S4	29	BS	Nutrition and Food Sciences	Grade 7-12 Science
S5	27	BS	Biology	Grade 7-12 Science
S6	38	BS	Mechanical Engineering	Grade 7-12 Science

3.3 Data Collection

Pre-program application essays and professional practice Vermont Licensure Portfolio (VLP) entries were the primary sources of data for this study that examined pre-post changes in professional self-efficacy of Scholars in the Noyce Program. All six Scholars wrote an essay at the point of application to the MAT Program that was compared to a professional practice essay (or portfolio entry) that each developed as part of the required VLP near the completion of the MAT Program. A summary of the graduate application and licensure portfolio essay questions are presented in Table 3. below.

Table 3. MAT Pre and Post Essay Questions

MAT Application Essay Question
Outline your reasons for wishing to undertake graduate study, and comment on your career plans. Describe the strengths and weaknesses of your preparation for graduate study in your proposed field. If you are presently in a graduate program, please explain why you wish to apply to a new program. If there are gaps in your academic career, please address them.
Vermont Licensure Portfolio Professional Practice Questions
Demonstrate your ability to thoughtfully describe, critically analyze, and insightfully reflect upon your readiness for professional responsibility. In this essay you should demonstrate how you as a teacher licensure candidate are prepared for self-directed, continuous professional learning practice in a legal and ethical manner, prepared to collaborate with stakeholders (such as learners, families, colleagues, other school professionals, or community members) to ensure student learning and prepared to advance the profession through advocacy, leadership and/or action research.

4. Findings and Results

As previously described in the literature review (2.2) and methods section (3), professional transitions encompass at least 5 recurring and interrelated themes including personal experience (Experiences), challenges in career goals (Challenges), changes in career goals (Goals), satisfaction and confidence in professional roles (Confidence), and development of professional knowledge and skills over time (Professional Knowledge). All five professional transition themes were observed to varying degrees in either the pre or post essays for all the Noyce Scholars engaged in this study.

In addition, growth in professional self-efficacy was evident in the themes of *Experience* to a limited extent, and for *Challenges in Career Goals*, and *Development of Professional Knowledge and Skills* to a greater extent for the cohort on the whole. Table 4. summarizes the results of a comprehensive analysis of the presence of personal and professional self-efficacy evident in pre and post study essays.

Table 4. Presence of Personal and Professional Themes

Scholar Growth in Professional Self-Efficacy										
Source: (T1) = Application essays and (T2) = Program completion portfolio essays										
Per = Personal Emphasis, Pro = Professional Emphasis										
Scholar	Experience		Challenges		Goals		Confidence		Knowledge	
	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
S1	Per	Pro	Per	Pro	Pro	Pro	Per	Pro	Per	Pro
S2	Pro	Pro	Per	Pro	Pro	Pro	Pro	Pro	Pro	Pro
S3	Per	Pro	Per	Pro	Pro	Pro	Pro	Pro	Pro	Pro
S4	Pro	Pro	Pro	Pro	Pro	Pro	Pro	Pro	Per	Pro
S5	Pro	Pro	Per	Pro	Pro	Pro	Pro	Pro	Per	Pro
S6	Pro	Pro	Pro	Per	Pro	Pro	Pro	Pro	Per	Pro

Since the Noyce program recruited graduate students who had varying degrees of pre-professional knowledge and experience and who were relatively mature in age (mean age = 30), it was expected that unlike undergraduate students, the Noyce Scholars would exhibit attitudes and dispositions that reflected their more advanced maturity and professional experience. Data analysis revealed similar pre and post experiences related to the profession of teaching, challenges faced by Scholars in their year-long internship, career goals identified and honed for development, questions and confidence in their ability to teach, and the continued development of professional knowledge and skills over time. These findings reflect both the maturity of the Noyce Scholars as well as the internship and coursework experiences they acquired as part of their MAT Program participation.

The development of personal and professional self-efficacy was evident in the pre and post essays of each of the six Scholars in the study. The Scholars demonstrated confidence in their ability to manage a variety of unique challenges as well as the knowledge and skills to effectively teach a wide range of learners. Pre and post essay analysis revealed areas of significant growth for Scholars that included challenges in career goals and advancement in professional knowledge and skills. Challenges reported by Scholars at the pre-application stage often focused on personal views of themselves as students as compared to post MAT program completion that reflected seasoned views of their professional growth as novice teachers and confidence in their ability to teach a diverse population of learners. Knowledge apprehension at the pre-application stage reflected personal concerns about their perceived lack of both disciplinary and professional teaching competence as compared to post completion essays that demonstrated confidence in disciplinary content knowledge, professional knowledge of the teaching practice and their developing confidence and skills to teach a wide range of students.

An in-depth analysis of Scholar application essays revealed a range of self-efficacy expressions that are characterized by the Scholars' aspirations and enthusiasm as well as their weaknesses, shortcomings and limited knowledge and skills as they embarked on the teaching profession. These expressions of self-efficacy can be compared to post essays that exhibited professional self-efficacy expressions that demonstrate reflective thinking, peer collaboration, community of practice, and an interdisciplinary student-centered teaching practice. Table 5. represents excerpts from pre and post essays of three Scholars that illustrate their professional self-efficacy as it relates to the themes of professional confidence and professional knowledge and skills.

Table 5. Pre and Post Confidence and Professional Knowledge Essay Excerpts

ID/Theme	Pre-Essays	Post Essays
S6 Confidence	I recognize that great teachers do more than teach, and I will need to develop many other skills required of teachers, such as	Reflection plays a major role in my growth, and I believe that my professional contributions will only become more

	<p>counseling, parenting, and coaching. My hope is that the UVM graduate teaching program and internship experience will help me grow into the other aspects of a teaching career. Despite my weaknesses, which I believe time and experience will help overcome, I believe that I am uniquely prepared to bring high school students a comprehensive education. I am eager to bring my passion of learning by returning to education as an educator and also a student.</p>	<p>valuable as I thoughtfully consider my role and experiences when sharing my ideas with members of my professional community. Throughout the school year, I held back my personal and professional contributions because I doubted that my insights and experiences would add to the discussion. With the luxury of hindsight, I realize that there is no burden to “add” to the discussion, only the opportunity to contribute to it. Therefore, my plan moving forward is to call upon the other professionals around me to help with planning, classroom management, and emotional support, and I will make myself socially available to my peers who want the same from me.</p>
S3 Knowledge	<p>My love of teaching yoga, training new employees, and in search for a newer more rewarding job led me to want to pursue a master’s degree in teaching. I truly believe if I am given to the chance to learn education skills and techniques I will be a great candidate for the MAT program. These past five years have been demanding, confusing and sometimes even heart breaking, but the glimmer of hope lingers in my pursuit of one day becoming a teacher that will aid in manifesting the dreams of the children of our future. I would cherish the opportunity to combine my enthusiasm for the sciences and my passion for working with others to pursue a future in education.</p>	<p>As first year teachers, we all are going to make a few mistakes. There are going to be moments where we fumble through our lessons, under perform during an observation with a principle, or unintentionally ignore a student’s thoughtful comment. Mistakes are unavoidable when you are settling into a new profession. That is why it is so important to seek out professional learning and lean on your teaching community. When I first started teaching, I was inclined to demonstrate and explain everything. After my first observation I realized how detrimental this practice could be. After this observation, I pushed students to talk amongst themselves first, before coming to me with questions they were more than capable of answering.</p>
S4 Knowledge	<p>In my work with teens I have a tendency to empathize with students by reflecting on my own memories. This habit creates a narrow field of view through which to understand students. Through courses and observation, I will widen this perspective continuing to emphasize with students but in a more inclusive way. I also expect this program to give me a foundation in effective teaching methods. At present, I learn a great deal through trial and error which is unfair to students.</p>	<p>My strengths in fostering student learning and understanding lie in designing learning experiences that draw on engaging, meaningful content. I do this by leveraging the interdisciplinary nature of the team to draw parallels between content areas. For example, we do this by studying sickle cell disease connected heritable traits and systemic inequality and racism (themes addressed in Social Studies and Language Arts). Another way that I draw students into authentic engagement with the science learning targets is by using what I know about their strengths and interests. When curating a list of possible topics for research, I made special efforts to find topics that might interest specific students.</p>

5. Discussion and Conclusions

An analysis of Noyce Scholar pre and post essays demonstrates clear evidence of the development of personal and professional self-efficacy. It might be argued that the context of the pre-application essay as preceding the Scholars' experience of the program may have led applicants to write about personal rather than professional self-efficacy. However, most of the applicants cited their pre-application teaching related experience without describing how these experiences were related to their self-efficacy. In addition, it seems likely that the amount of experience in teaching related occupations (nearly an average of ten years for this cohort of Scholars) provided a sufficient basis for their reflection. Three of the six applicants expressed a desire to become more effective teachers in the pre-application essay.

The majority of Scholars reflected confidence in their ability to teach a wide range of learners in their post program portfolio essays. Professional self-efficacy and growth was most evident in the expressions of the theme of professional knowledge and skills. Changes in Noyce Scholar professional self-efficacy from pre to post MAT program completion were demonstrated in the Scholars' abilities to be reflective and cognizant of their professional self-efficacy as they progressed through the MAT program. Scholar post essays demonstrated the importance of peer collaboration, the development of teaching and organizational practices that integrate student-centered teaching strategies and growth in professional attitudes of accomplishment and enthusiasm with themselves and their overall teaching practice

The analysis of essays written by the 6 Scholars during the MAT application phase and again at program completion provided a sampling of Scholar perceptions of how they considered their readiness and comfort with developing the role of teacher over the course of the MAT Program. Findings from this study included confirmation of the perception of growth in professional confidence and knowledge among the cohort of Scholars. We recognize limitations of this study may include its small sample size as well as the fact that pre and post essays questions were not identical. Future studies might include a larger sample size of Scholars as well as entail the utilization of the Vermont Licensure Portfolio entry questions as pre and post questions for the study.

In addition to documenting the effects of the program on Scholars' professional self-efficacy, this study serves as a potential gateway to more extensive research that might be the subject of future study of Noyce Scholar development. Potential investigations may include examining the relationship between Scholars use of assessment data from their students and the level of clarity and intensity of their own views of self-efficacy.

References

- Bamburg, J. D. (1994). Raising expectations to improve student learning (Urban Monograph Series, CS). Oak Brook, IL: North Central Regional Educational Lab.
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. Englewood Cliffs, NJ: Prentice Hall.
- Bischoff, P., French, P. & Schaumlöffel, J. (2017). A longitudinal essay analysis of Noyce Scholars' growth in self-view on teaching science in high-needs school districts. *International Journal of Environmental & Science Education*. Vol. 12, No. 5, 1217-1232.
- Creswell, J. (2015). *30 Essential Skills for the Qualitative Researcher*. Los Angeles, CA: SAGE.
- Guo, Y., Piasta, S. B., Justice, L. M., & Kaderavek, J. N. (2010). Relations among preschool teacher's self-efficacy, classroom quality, and children's language and literacy gains. *Teaching and Teacher Education*, 26(4), 1094-1103.
- Hamman, D., Olivarez, A., Jr., Lesley, M., Button, K., Chan, Y., Griffith, R., & Elliot, S. (2006). Pedagogical influence of interaction with cooperating teachers on efficacy beliefs of student teachers. *The Teacher Educator*, 42, 14-29.
- Joyce, B., Hersh, R.H., & McKibbin, M. (1983). *The Structure of School Improvement*. New York: Longman.
- Kirchoff, A. & Lawrenz, F. (2011). The use of grounded theory to investigate the role of teacher education on STEM teachers' career paths in high-need schools. *Journal of Teacher Education* 62(3) 246–259.
- Liou, P. Y., Desjardins, C. D., & Lawrenz, F. (2010). Influence of scholarships on STEM teachers: Cluster analysis and characteristics. *School Science and Mathematics*, 110(3), 128-143.

- National Science Foundation Authorization Act of 2002 (P.L. 107-368). Retrieved from https://www.nsf.gov/mps/ast/aaac/p_1_107-368_nsf_authorization_act_of_2002.pdf.
- National Science Foundation Robert Noyce Scholarship Program. Retrieved from <https://www.nsfnoyce.org/>.
- National Science Foundation Robert Noyce Scholarship Program Solicitation (2017). Retrieved from <https://www.nsf.gov/pubs/2017/nsf17541/nsf17541.htm>.
- Ryel, R., Bernsau, D., & van Tassel, F. (2001) Advocating resiliency through wellness. Paper presented at the 2001 Association of Teacher Educators annual meeting, New Orleans: LA.
- Shoulders, T. L., & Krei, M. S. (2015). Rural high school teachers' self-efficacy in student engagement, instructional strategies, and classroom management. *American Secondary Education*, 44(1), 50-61.
- Stake, R. (2000). Case studies. In N.K. Denzin & Y.S. Lincoln (Eds.). *The Handbook of Qualitative Research* (pp. 435-450). Thousand Oaks, CA: Sage Publications.
- Tschannen-Moran, M. & Woolfolk Hoy, A. (2001). Teacher efficacy: capturing an elusive construct. *Teaching and Teacher Education*, 17, 783-805.
- Vermont Agency of Education. The Vermont Licensure Portfolio. Retrieved from <https://sites.google.com/site/vermontlicensureportfolio/>.
- Whitfield, J. (2016). Comparing Noyce Scholars' decisions to teach and perspectives on teaching to non-noyce scholars. In Lawler, B. R., Ronau, R. N., & Mohr-Schroeder, M. J. (Eds.). Proceedings of the Fifth Annual Mathematics Teacher Education Partnership conference. Washington, DC: Association of Public Land-grant Universities.
- Woolfolk-Hoy, A. E. (2005). What predicts student teacher self-efficacy? *Academic Exchange Quarterly*, 9(4), 123-127.

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