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## What's the Value? Measuring Value in Complex Social Learning Environments with Pre-service Mathematics Teachers

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### Abstract

At the national level, undergraduate mathematics teacher preparation programs are shifting to develop teachers who not only understand current research-informed instructional practices but also have firsthand experiences learning, teaching, and collaborating in student-centered environments (CBMS, 2016). Understanding the degree to which these experiences impact pre-service teachers' learning is challenging to measure. This paper describes the efforts of a Track 1 National Science Foundation (NSF) Robert Noyce Teacher Scholarship grant to recruit and provide wider professional experiences to develop high-quality secondary mathematics teacher candidates and how the research team utilizes a value framework (Wenger, Traynor, & de Laat, 2014) to study programmatic impact. The guiding questions for this research are: *To what extent do pre-service mathematics teachers value participation in extended programs to support their work as mathematicians and future teachers?* and *How can researchers and practitioners measure value as a construct?* This paper examines: (a) how we leverage the value framework in a variety of ways, (b) preliminary findings on what Noyce participants value and the experiences that led to their learning, and (c) implications for future work in pre-service mathematics teacher preparation programs.

### Introduction and Background

Teacher preparation programs, especially those focused on STEM education, are evolving to address a national shortage of highly qualified secondary STEM educators. In particular, teacher education programs are partnering with mathematics departments to coordinate course and field experiences that develop teacher candidates' content and pedagogical knowledge to accommodate this need. In 2013, the University of Nebraska at Omaha received a Track 1 Noyce grant from the NSF, with the aim of creating a dual-enrollment program through the mathematics and teacher education departments to recruit, develop, and retain highly qualified secondary mathematics teachers. Unlike many other collaborative teacher preparation programs, the NebraskaMath Omaha Noyce Partnership program (Omaha Noyce) provides not only scholarships and aid for undergraduate students, but also access to "wider professional experiences" (WPEs) that extend beyond traditional field experiences in schools and classrooms (Darling-Hammond & Bransford, 2005). These experiences include participants engaging in activities such as serving as learning assistants for undergraduate mathematics courses, providing mathematics tutoring services (both at the K–12 and university level), volunteering at local community and K–12 school STEM events, and hosting K–12 STEM math circles at the university.

Providing undergraduate pre-service teachers access to these sorts of WPEs requires coordination and commitment among participating university faculty members. Engaged faculty act as mentors and liaisons for students to gain access to WPEs through Omaha Noyce, the Omaha STEM-Ecosystem, Metropolitan Community

College, and local K–12 partnerships (MTE-P Guiding Principles 1 & 2). The Omaha Noyce program aims to identify what components of the program are most valuable in the development and retention of these future secondary mathematics teachers and how their WPEs might further inform how the educational community defines “highly qualified” teachers beyond traditional teacher preparation requirements. In this paper, we describe the research and evaluation methods of the Omaha Noyce program in terms of the complex construct of “value” in social learning, share preliminary findings on what Noyce participants value and what experiences led to their learning, and discuss future implications and next steps of this work.

### Social Learning and Value

Gathering and analyzing data involves social interactions among undergraduate students. Thus, the research team utilized situated learning theory (Lave & Wenger, 1991; Wenger, 1998), which posits that learning is an inherent part of participating in an organization, and learning goes beyond that which occurs in the traditional classroom setting to include shifting “toward full participation in the sociocultural practices of a community” (Lave & Wenger, 1991, p. 29). Through the Omaha Noyce program, “learning” occurs in a variety of contexts, cyclically and over time. The research team therefore grounded this study using Wenger, Traynor, and de Laat’s Value Framework (2011; 2014), which defines cycles of value creation ranging from “immediate” to “transformative” value (see Figure 1).

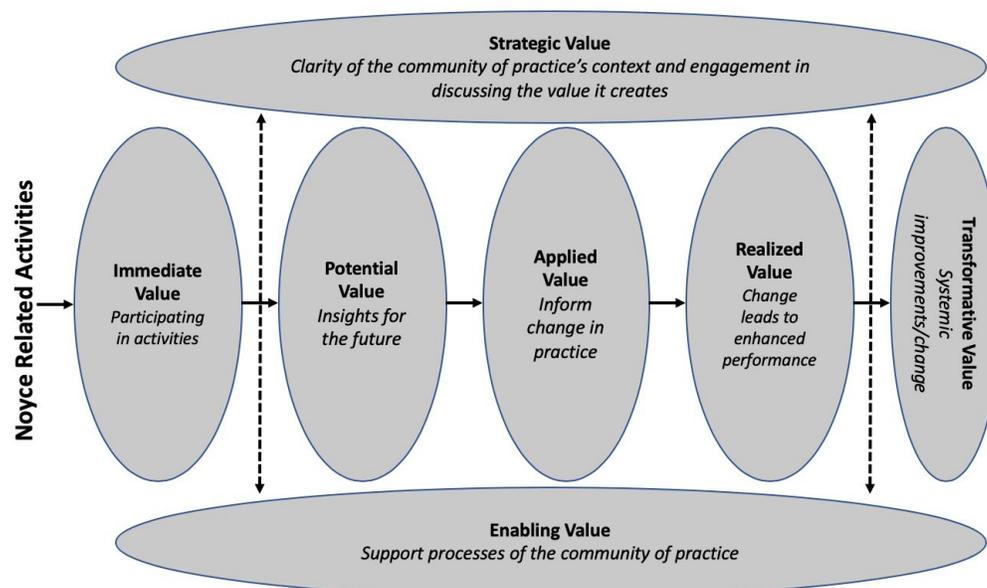


Figure 1. Seven Types of Value, adapted from Wenger-Trayner & Wenger-Trayner (2014) with permission.

The framework is not intended to be hierarchical in nature; rather, it is a fluid and interconnected process of developing and applying learning (Wenger et al., 2011). The “organization” in this case is the cohort of undergraduate students in the Omaha Noyce program, most of whom are interested in pursuing a career in secondary mathematics education.

### Measuring a Complex Construct

Participants of the Omaha Noyce program, and our study, included a total of 16 Interns, typically freshmen and sophomores who demonstrated an interest in STEM education, and 10 Scholars, typically juniors and

seniors who committed to completing a dual-degree program through the mathematics and teacher education departments as secondary mathematics teachers. Some overlap exists between Interns and Scholars, as some participants used the internship as a pipeline into the scholarship program. During the fall and spring semesters, participants completed weekly structured reflections on the WPEs in which they engaged. Additionally, participants completed a structured end of semester reflection examining their experiences holistically.

The research team analyzed three semesters of journal entries, from Fall 2018 to Fall 2019, to better understand the types of value students experienced through participation in WPEs. The team developed a codebook using each of the value types as *a priori* “parent codes,” and descriptive coding to create nested “sub-codes” based on the topical experiences within which participants found value (Saldaña, 2016). All journal entries were coded by two researchers, who discussed and reconciled coding to ensure the validity and reliability of the results. The researchers then utilized Nvivo12 software to run queries, focusing on the “immediate” and “potential” value that participants found engaging in WPEs. “Immediate” value indicates in the moment expressions of interest or learning, and “Potential” value refers to participant comments suggesting future use of a particular learning as a teacher.

### Preliminary Findings

Immediate and potential value parent and sub-codes were more frequently present in student reflections than other value codes. The frequency of coding might reflect the developmental level of these undergraduate students and their access—or lack thereof—to learning opportunities to realize, apply, or transform their understanding of mathematics teaching and learning. Their WPEs included activities like serving as teaching assistants and tutors, facilitating outreach events, and/or attending workshops. While these WPEs are all related to mathematics and teaching, oftentimes, they occur in isolation without explicit connections drawn among activities. This may have limited the cyclical opportunity for participants’ experiences to progress to applied, realized, and transformative value.

Another preliminary finding emerged in the intersection of immediate and potential value experiences. In these experiences, Noyce participants found not only value in the learning opportunity at hand, but also voiced implications for their future as a learner or teacher of mathematics. One intern stated,

In being a TA [teaching assistant], I realize I have to really know every step to working out problems. When students asked for help during class, I often caught myself from just telling them the answer. I thought back to when [a former Scholar] was my TA in Calculus and how he really encouraged me to learn the steps and be more independent with Calculus. Therefore, I have to step back and let the students be more confident in their work.

In this moment, the intern voiced concurrent immediate and potential value in not only deeply understanding mathematics and working alongside a learner but also how the experience informed future actions the intern might take supporting students in the future (MTE-P Guiding Principles 4 &5). A Scholar shared a similar immediate/potential value interaction while volunteering in a former Omaha Noyce participant’s classroom:

While tutoring in this (high school) class, I encountered something new. There was a student who did not realize that zero is greater than any negative number. This student was pretty far along in Algebra. I kept wondering how did this student make it this far without this knowledge? Also how many other students don’t know that zero is greater than any negative number? Encountering this just reaffirmed for me, how important it is to get qualified and enthusiastic math teachers in the classroom. Sometimes school and life can become overwhelming and then something like this comes along and makes you realize that all this hard work will be worth it in the end.

In this scenario, access to a real classroom and students led by an early-career teacher provided an opportunity for reflection about the diverse learning and social needs of high school students. While expressing immediate and potential value in the interaction, this opportunity also highlights the capacity building value of WPEs and how they offer Noyce participants unique and self-determined opportunities for realizations and affirmations about the importance of high-quality mathematics instruction for all students.

### Considerations for the Field and Next Steps

Utilizing the value framework (Wenger, et al., 2011; 2014) within the complex Omaha Noyce learning environment has opened doors to a variety of further research and evaluation considerations. The preliminary findings offer opportunities to follow these participants further into their early teaching careers, or otherwise chosen career field, to examine any sustained or evolving value stemming from their participation in the Omaha Noyce program. Additionally, the value framework has been a tool for reflection and refinement of the leadership team as Noyce participant reflections are leveraged to pinpoint “high impact” WPEs we want all participants to have access to exploring as an Intern and/or Scholar. Implications of better understanding what WPEs create the most value for Noyce participants can have broader implications to teacher preparation programs and also how we might increase recruitment and retention of secondary mathematics teachers. For example, we have found Noyce participants gain value in tutoring through increased understanding of teaching practices and how students learn. Investigating value as a construct has immense capacity to glean vital information not only about program participants but also programmatic structures that result in the greatest impact.

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