

STEM Teaching and Teacher Retention in High-Need School Districts

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Abstract: This case study sought to identify components attributed to promoting effective mathematics and science teaching through the WISE teacher preparation program and in the initial years of teaching. In addition, teachers’ strengths and areas for improvement related to effective teaching and student learning were explored; and their career path trajectories were followed to identify shifts in employment, retention, and leadership. Findings of the study suggest that conference attendance, STEM communities of practice, and university-based mentoring facilitated effective teaching in concert with coursework and clinical experiences. Moreover, administrators indicated that WISE teachers were above average, or “exceptional,” in comparison with induction teachers, and all plan to continue teaching in the foreseeable future.

KEYWORDS: *professional development, induction, mentoring, STEM, teacher retention*

NAPDS NINE ESSENTIALS ADDRESSED:

1. A comprehensive mission that is broader in its outreach and scope than the mission of any partner and that furthers the education profession and its responsibility to advance equity within schools and, by potential extension, the broader community
2. A school-university culture committed to the preparation of future educators that embraces their active engagement in the school community
8. Work by college/university faculty and P–12 faculty in formal roles across institutional settings

As the number of teaching positions has increased across many states in the last two decades and teacher retention has declined, particularly among the newest teachers (Ingersoll & Merrill, 2010; Ingersoll, Preston, Tekkumura-Kisa, Southerland, & Wright, 2018), preparing effective teachers and supporting these teachers in their induction years have become major areas of focus. Effective teachers have been shown to not only increase learning, but to impact economic and social outcomes as well (Chetty, Friedman, & Rockoff, 2014). Therefore, cultivating effective teachers, promoting teacher leadership, and retaining these effective teacher leaders are critical to the long-term outcomes of their students.

Through a university-school partnership and a National Science Foundation (NSF) Robert Noyce Teacher Scholarship Program grant, Winthrop University has implemented systematic programs and experiences to prepare and support teachers in becoming effective STEM educators who are retained in their induction years and become leaders in the field. The Winthrop University-School Partnership Network (WUSPN) consists of nine districts (more than 50 schools) in South Carolina. The NSF-funded Noyce project, named the Winthrop Initiative for STEM Educators (WISE), is designed to increase the number of effective mathematics and science teachers in high-needs school districts.

This case study sought to identify components attributed to promoting effective mathematics and science teaching through the WISE teacher preparation program and in the initial years of teaching. In addition, teachers' strengths and areas for improvement related to effective teaching and student learning were explored; and their career path trajectories were followed to identify shifts in employment, retention, and leadership.

Research Setting

The Winthrop Initiative for STEM Educators (WISE) seeks to recruit and prepare future teachers as well as provide professional development, coaching, and mentorship during the initial years of teaching. Four predominate activities occur: 1) 3-week paid internship with on-campus housing provided each May targeted at first- and second-year undergraduates that includes implementing lessons in STEM fields at two WUSPN schools (one middle school; one high school); 2) Scholarships for students majoring in mathematics or science (or career changers) who agree to teach for a designated number of years in high-needs school districts, particularly WUSPN schools; 3) Ongoing professional development for WISE teachers (alumni) and WUSPN teachers and administrators. And funds to attend state or national conferences to facilitate networks and promote teacher leadership; and 4) Coaching and mentorship by university-based WISE mentors during student teaching and in the induction years of teaching in concert with school mentors and administrators.

The focus of this case study, using an action research approach while also reanalyzing historical data related to two cohorts of WISE graduates, is specifically on the professional development, coaching, and mentorship of WISE graduates teaching within the WUSPN that lead to effective teaching, teacher retention, and teacher leadership. This study also explores strengths and areas for improvement related to teacher effectiveness as perceived by multiple stakeholders including WISE teachers, WISE university-based mentors, and school administrators associated with each WISE teacher.

Theoretical Framework

The importance of teacher effectiveness in improving student outcomes, particularly student learning and achievement, has been well documented. While many factors are associated with student achievement, the impact of the teacher is among the greatest school-based factors, with estimates between 7% and 21% of the variance in student achievement attributed to the effectiveness of the teacher (Nye, Konstantopoulos, & Hedges, 2004; Hattie, 2009). Hattie (2009) indicated that teacher effectiveness may be more variable between content areas as well. "The

variation in teacher effectiveness is much greater for mathematics than reading outcomes (11 percent on average for mathematics compared to seven percent for reading),” (Hattie, 2009, p. 109).

In a study of elementary mathematics teachers in Washington, Goldhaber, Liddle, Theobald, and Walch (2012) found that an effective mathematics teacher could reduce the achievement gap by about one-fifth between economically disadvantaged students and their economically advantaged counterparts. “Our findings suggest that a one standard deviation increase in teacher effectiveness ... would increase student achievement by about 18 percent of a standard deviation,” (p. 4). The researchers estimate an additional 2.6 months of learning and achievement in an academic year among students who are taught by an effective teacher.

Teacher education (preparation programs) in general have demonstrated limited impact on teachers’ effectiveness (Goldhaber et al., 2012; Hattie, 2009). However, teacher education programs are integrating elements associated with teacher effectiveness such as communities of practice and the provision of feedback within coursework and pre-service experiences. In addition, some teacher education programs are taking a more active role in understanding the effectiveness of their graduates and working with districts through mentorship or coaching initiatives to increase the effectiveness of teachers.

Darling-Hammond, Hyler, and Gardner (2017) identified seven components of effective professional development based on findings from 35 studies that linked professional development to student outcomes. Professional development that is “content focused,” “incorporates active learning,” “supports collaboration,” “uses models and modeling of effective practices,” “provides coaching and support,” “offers opportunities for feedback and reflection,” and “is of sustained duration,” has been linked to effective teaching (p. 1). Through its partnership network and WISE initiative, Winthrop has incorporated many of these facets, including a sustained coaching and feedback process that begins during the preparation program and extends into the induction years of teaching.

Coaching has emerged as a supplement or alternative to professional development sessions to increase teacher effectiveness. Kraft, Blazar, and Hogan (2018) conducted a meta-analysis including 49 studies related to the impact of coaching that found “...large positive effects of coaching on teachers’ instructional practice,” (p. 561). As coaching is becoming more prevalent, particularly within induction mentoring programs, it is important to understand and review the impacts of coaching in developing effective teachers who foster student learning.

In tandem with aspects to enhance educator effectiveness through professional development and coaching, Ingersoll and Merrill (2010) note rising teacher attrition with annual teacher turnover rate increasing from 13% in 1991–1992 to 17% in 2004–2005, with teacher turnover after the first year of teaching approaching 30%. Teachers report leaving for a variety of reasons and some move to another district within their state or to higher-level positions; therefore, attrition must be understood within this context. National research on teacher retention reveals that larger focus and amounts of “coursework in teaching methods, practice in teaching, selecting materials, psychology/learning theory, and teaching feedback” all contribute to retention (Ingersoll et al., 2018, slide 8).

In South Carolina, the Center for Educator Recruitment, Retention, & Advancement (2019) produces an annual report using data provided by 85 South Carolina school districts or public school entities. The number of teaching positions and vacancies in South Carolina schools

continues to increase, highlighting the need to prepare more teachers to meet the needs of the state. In 2018-19, there were approximately 52,600 teaching positions within 85 districts or public school entities in South Carolina. Approximately 7,600 teachers were hired for 2018-19, a 4% increase from 2017-18. Middle and high school mathematics teachers account for 7.5% of all teachers, and science teachers account for 7% of all teachers.

While the numbers of South Carolina teaching positions are increasing, approximately 7,300 teachers left their positions as of the beginning of the 2018-19 school year, which is a 10% increase since 2016-17 and a 28% increase since 2014-15. Approximately 5,300 of these teachers left the profession completely. The number of first year teachers leaving their schools has increased by 29% since 2014-15 with 530 first-year teachers leaving after their first year in 2014-15 compared to 690 in 2018-19 (Center for Educator Recruitment, Retention, and Advancement, 2019).

Vacancies in middle and high-school mathematics and science accounted for 10% and 7.2% of all South Carolina vacancies respectively. Science vacancies increased from 3.5% in 2017-18 to 7.2% in 2018-2019. This corresponds with national data that find that 14.5% of mathematics teachers and 18.2% of science teachers leave the field after their first year of teaching (Ingersoll et al., 2018).

Research Methods

The problem of practice is variability in the effectiveness of teachers (particularly in STEM), which influences student outcomes and high attrition rates of early career teachers within mathematics and science. South Carolina, with its increasing number of teaching positions and increasing number of vacancies, needs to implement and evaluate programs and initiatives that seek to address these issues to ensure the success of its students and their future outcomes, particularly as these outcomes are associated with the vitality of the state.

The Winthrop Initiative for STEM Educators (WISE) sought to address these issues through a multipronged approach throughout preparation and induction in conjunction with WUSPN district efforts in the university's surrounding region. While WISE has graduated three cohorts of students between May 2017 and May 2019 (n=13 students) in this phase of implementation, focused research on the professional development, mentorship, and coaching provided within their induction years (May 2017 and May 2018 graduates only) was needed to understand teaching effectiveness and retention in the field.

Research Questions and Design

The research questions that informed this action research/evaluation approach were:

1. What are strengths and areas for improvement perceived by WISE stakeholders (WISE graduates, WISE mentors, and school administrators) related to effective STEM teaching and teacher retention?
2. How do WISE-facilitated supports and activities delivered within a university-school partnership influence the effectiveness and retention of mathematics and science teachers?

To answer these research questions, case study research (Yin, 2018) was used focused on a single-case design with an action research approach that included interviews, focus groups, surveys, and

document analysis associated with teachers who participated in WISE and were currently teaching in WUSPN schools.

Research Participants

As of the 2018-2019 academic year, five of the eight graduates in two graduating cohorts (2017 and 2018) were employed at four schools within WUSPN districts and were involved in this research: two biology teachers and three mathematics teachers. Three high schools were in urban or suburban areas; whereas, one was in a rural area. The other three graduates from the 2017 and 2018 cohorts were teaching within districts not involved in the WUSPN. Information related to the high schools in which these five teachers were employed is included in Table 1. Two graduates were teaching within the same high school in 2018-2019.

	# students	% students in poverty	# teachers	Average teacher salary	Principal years of experience	% graduates enrolled in higher ed.
High School 1	2218	18.5	132	\$52,796	12	87.0%
High School 2	1982	53.0	117	\$54,013	7	62.8%
High School 3	1868	50.4	105	\$52,649	15	65.5%
High School 4	367	75.2	29	\$46,495	1	74.1%

Table 1: 2018-2019 WUSPN High Schools of Mathematics and Science Teachers in Study

Data Collection and Analysis

Semi-structured interviews were conducted with (a) one WISE mentor who conducted multiple observations with each teacher during a two-year period and (b) three administrators who supervise these teachers. One administrator left the district in summer 2019 during the interview process and was not available to participate in the interviews. Audio recordings from 2017 and 2018 graduating WISE scholar focus groups were reanalyzed to identify themes related to teacher preparation identified at the time of graduation by current first- and second-year teachers involved in the study.

An online survey was administered in April 2019 to gain these teachers' perceptions of the coordination and delivery of supports by WISE and their respective schools. The survey included 18 closed-response items and two open-response items. Closed-response items were summarized using descriptive statistics. Open-response items were coded and grouped into open and axial themes.

Information on the progression of these students through the program as well as their trajectory upon graduation including initial school of employment and school of employment at the time of the study were analyzed based on programmatic documents. In addition, the principal of record at each school was documented during the years that each WISE teacher was employed.

A grounded theory approach was used to analyze data from multiple sources. Initially, open codes were developed across the interview data, focus group data, survey data, and document analysis. Then, open codes were grouped into axial codes by cross-referencing data using a constant comparison process (Corbin & Strauss, 1990; Merriam & Tisdell, 2016). In some instances, data from all eight graduates were used because the teachers were unable to be identified within the context (e.g., focus groups conducted at graduation and anonymous survey data).

Research Findings and Discussion

The overlay of the NSF-funded WISE program within the university-school partnership network seems to have created conditions that enhanced the preparation and perceived effectiveness of STEM teachers. While stakeholders highlight the importance of coursework and clinical experiences within partnership school districts in preparing students to be effective teachers, opportunities and supports provided by WISE were cited as critical in developing these teachers' skills and leadership abilities.

Cultivating Effective Teaching and Promoting Teacher Leadership

Three professional development activities were cited most frequently related to the development and support of effective teaching by WISE students, WISE graduates, WISE mentors, and current school administrators: 1) attendance and networking at local, regional, and national science and mathematics conferences supported through NSF funding/WISE program; 2) the "WISE Community" described as a network of current WISE scholars and alumni (teachers) that are active through social media and on-campus meetings; and 3) support of WISE faculty and mentors including additional "low-stakes" observations that occur for WISE participants during their student teaching and induction years of teaching.

STEM Professional Conferences. WISE stakeholders frequently referenced conference attendance as a critical part of these teachers' development including networking with other teachers and gaining insight into teacher leadership and innovation in STEM. WISE teachers cited the importance of the conference in learning from other teachers and gaining practical strategies that they could use in their classrooms. According to one WISE teacher:

There would be no way that we could pay for [conferences] without WISE. They provide us with transportation and hotels. That is one of the most beneficial things WISE has done for us. We learned a lot of different teaching strategies [interactive notebooks] and gained different activities that we can incorporate into our classroom.

STEM Community. The WISE Community was also cited by WISE teachers and a WISE mentor as a support system and community of practice for these STEM teachers. According to a WISE teacher, "On top of the [WISE] advisors, we had a support group. We might not have had that support group if we didn't have this program together and getting advice from the past WISE scholars too." Another WISE teacher said:

We did a lot of networking...knowing that we had a support group specifically for us. I love a lot of my education professors and I would reach out to them and it

was nice to know that these specific people know me so personally and let me vent and told me it would be fine.

Principals did not specifically cite the WISE Community, but all of them noted that these teachers were above average, or “exceptional,” compared to induction teachers in general and some speculated that the preparation and support that they received helped their teaching effectiveness in their initial years in the classroom. According to a WISE teacher, “The connections, resources, and support you get from WISE...gives you an advantage.”

Mentorship. WISE offers a formal mentor who conducts an observation during student teaching, and then, multiple observations during the first year of teaching for all WISE teachers. The purpose of the observations is to provide WISE teachers with feedback through a collegial, low-stakes process. WISE teachers can request specific focus areas for the mentor based on the South Carolina Teaching Standards 4.0 observation rubric, which is used in the South Carolina Expanded Assisting, Developing, and Evaluating Professional Teaching (ADEPT) System. In addition, the WISE mentors seek information about teachers’ transition from the university to the profession. According to a WISE teacher, “It is nice to know that we have another person to talk to.” Another WISE teacher indicated, “There were a few things the [mentor] asked such as, why did you call on these two students? So, it was good in a self-reflective way.”

In general, administrators were aware of the WISE mentors, and they indicated the importance of mentorship and support, particularly from an outside entity such as a university. Some of the administrators highlighted district and school-based induction mentoring programs that coincide with the WISE mentors. While difficult to coordinate, one principal highlighted the need to ensure that mentoring was not causing additional stress on new teachers based on these teachers’ coordination of multiple mentoring initiatives. In addition, some administrators cited coordination related to focus areas of mentoring by multiple initiatives as a potential need.

While formal mentorship through the designated WISE mentor was noted as a benefit by WISE teachers, these teachers also noted informal mentorship and support by WISE faculty and staff that began during teacher preparation and extended through their induction years of teaching. According to one WISE teacher:

[WISE faculty and staff] really do a tremendous amount for us.... because they really are such a huge help and go out of their way to help us, and they know us personally and individually support us based on our personalities and what they know our personal weaknesses are.

Induction Teacher Strengths and Areas for Improvement

Based on themes across data sources, there are strengths and areas for improvement related to effective teaching and teacher leadership that emerged, based on preparation activities and support systems in place during the initial years of teaching. Strengths identified included 1) preparation in lesson planning, content knowledge, and instructional strategies; 2) more adept lesson timing and pacing in the transition from student teaching to induction teaching; and 3) confidence in redirecting students and effectively managing classroom disruptions. WISE teacher survey results demonstrate perceptions on their preparation in key aspects related to effective teaching. Findings indicate that WISE teachers were more likely to strongly agree to being

prepared in developing lesson plans, using diverse instruction, managing student behavior, and incorporating technology (see Figure 1).

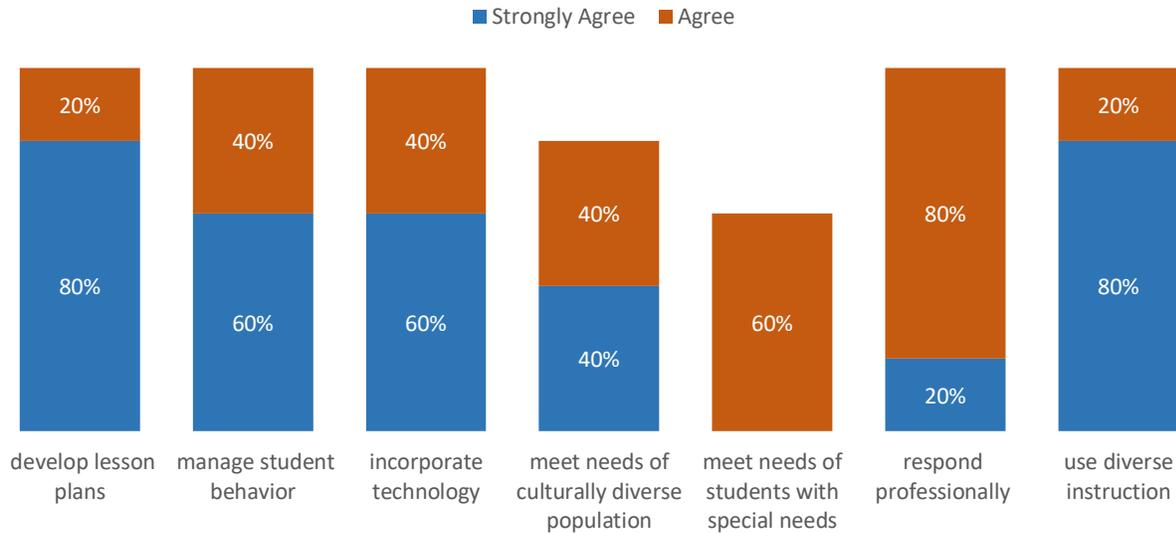


Figure 1: Teachers’ Agreement of Preparation/Ability in Aspects of Teaching

The greatest challenges faced by these first- and second-year WISE teachers included 1) meeting diverse needs of students, particularly related to English Language Learners and students with individualized education plans (IEPs) and 504 plans; 2) understanding state, district, and school regulations and requirements, including legal facets (e.g., when doors must be secured, how to deal with students or teachers leaving the classroom); 3) developing their own style, building on their strengths as teachers, and meeting the needs of their students rather than modeling strategies from their clinical experiences or other teachers; and 4) avoiding taking on too many extra responsibilities in the initial years of teaching, such as coaching school sports or leading school clubs.

WISE teachers attributed their experiences in WISE for increasing their leadership skills (80%) and confidence in working in a high-needs district (60%), a requirement of program. According to a WISE mentor, development and confidence transpired from student teaching to induction teaching:

Things that would bother some of them while they were student teaching didn’t bother them as much during their first year. Little classroom disruptions or when they would see something where they might have stopped the class previously, they would walk right over [address the problem] and keep teaching.

Based on WISE teacher survey data that corresponds to themes identified in interviews and focus groups, teachers perceived greater needs at the end of their first or second year of teaching for professional development in managing their classroom and teaching students of varying abilities than they did upon beginning their teaching career. In addition, these teachers report continuing needs for professional development in engaging students and incorporating research-

based practices; however, these are slightly lower now than when they entered the profession (see Figure 2).

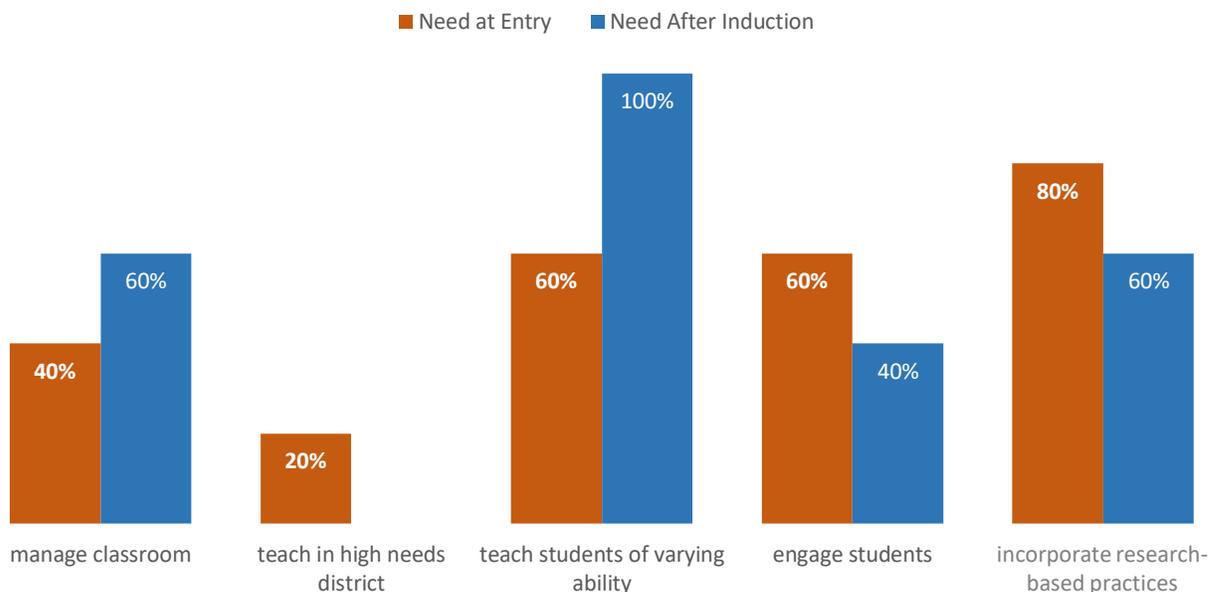


Figure 2: Teachers’ Professional Development Needs at Entry into the Profession and After Induction Year(s)

When asked if they are satisfied with the professional support provided by their current schools, 60% of WISE teachers agreed, and 40% strongly agreed; however, it is important to note that school changes and the principal transition occurred in summer 2019, after this survey was completed, which may impact these levels of satisfaction.

Promoting Retention

As of the end of their first or second year in the classroom, these teachers indicated that they all plan to remain in the classroom as long as they originally intended. Based on their ideas upon graduation in May 2017 or May 2018, this ranged between five years and their entire career. According to one WISE 2018 graduate, “Until I retire. I don’t want to leave the classroom.” A WISE 2017 graduate said, “I think I was planning on coming back to the college level to do math education. I don’t want to put a time stamp on it, but at least six to ten years, and then work on some more professional degrees.”

Across stakeholders, there was concern about burnout as many of these newer teachers spend numerous hours outside of school on teaching-related tasks. According to a WISE mentor, the teachers are overworked and exhausted during the first induction-level observation with the university-based mentor, which is typically at the 10-week mark of the academic year. This mentor specifically addressed methods and strategies to reduce stress and fatigue during the initial visit, and usually, these teachers report better work-life balance by the second visit.

In exploring the trajectory of these five WISE teachers and their schools, some teachers (40%) switched schools at the end of their first or second year of teaching. These school changes

may be a factor in their long-term retention and need to be considered to fully understand retention both within schools, districts, and the field. In addition, three of the four schools involved in this study have had administration changes within the last two years. These are factors to be considered as we continue to study the cultivation of effective teachers who become leaders in the field and factors that facilitate or impede teacher retention.

Implications for Practice

Based on these findings, Winthrop University may consider expanding opportunities, supports, and communities of practice for other certification areas using similar strategies to those offered to WISE students and teachers (alumni). These additional components, such as conference attendance, content area or certification-based communities of practice, and university-based mentorship during student teaching and the initial years of teaching lend themselves to the development of effective teaching and promote retention. Winthrop University was able to provide additional supports and resources for STEM teachers based on an NSF grant; therefore, it is important to determine the costs associated with this additional level of support and resources to support these costs.

There is a need to more fully address and integrate strategies and methods to enhance instruction for diverse groups of learners as well as better preparation to work with students with special needs, particularly meeting IEP and 504 plan goals. All stakeholder groups, including WISE teachers, recognized the need for more support in these areas.

Professionalism was highlighted by some stakeholder groups as an area for more focus during teacher preparation and induction mentoring. More specific training and modeling of expectations by the profession and schools were deemed priorities to ensure that teachers meet obligations such as being on time, attending required school meetings, and collaborating with their fellow teachers to improve student outcomes. In addition, gaining confidence and understanding in communicating with parents was identified as an area of professionalism in which more attention is needed among incoming teachers.

Limitations

This case study focused on a specific STEM-based initiative within a university-school partnership in one mid-sized university. Five teachers who participated in a STEM-focused teacher preparation program and were currently teaching in university-school partnership districts formed the basis of this work. While some information may be applicable to other teacher preparation and professional development programs, these findings may be unique to this setting. Teacher effectiveness is also difficult to define and conceptualize, and perceptions of teacher effectiveness may differ based on interpretations. We used a broad understanding of teacher effectiveness considering elements associated with effective teaching that is not confined to student assessments or student performance alone, which is important to consider related to these findings. Student assessment data and formal teacher evaluation data were not available due to confidentiality issues.

Conclusions

This case study found that conference attendance, a community of practice, and university-based informal and formal mentorship during teacher preparation and the induction years of teaching contributed to the cultivation of effective STEM teachers and the development of STEM teacher leaders. These WISE supports were layered onto coursework, clinical experiences, and university-school partnerships to enhance the effectiveness of these teachers in facilitating student learning in mathematics and science. In exploring their career path trajectories since graduation, some teachers have changed schools, and many have experienced administration changes at their schools during their initial years of teaching, but all plan to continue teaching in the foreseeable future. Additional research will focus on retention within their schools, districts, and profession over time, as well as on emerging teacher leadership and impact on student achievement as measured by end-of-course assessments or other measures of content mastery.

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