HELPING PROVISIONALLY LICENSED MIDDLE SCHOOL SCIENCE TEACHERS

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Abstract

The New Science Teachers' Support Network is a National Science Foundation-funded project that provides a multifaceted support system to provisionally licensed middle and high school science teachers. The teachers in this project were all hired to teach science, and had science degrees, but had little or no education coursework or background. Research is being conducted on the effectiveness of the support system we employed for these teachers, particularly on the factors that characterize the practice of new teachers, and on factors that lead to teacher success and teacher retention. In this paper, we describe the design of the study and the results from the one-year pilot study. We focus upon our observations and experiences with the middle school teachers in the group of participants; and, we close with preliminary recommendations for supporting provisionally licensed science teachers so they have the best chance of being successful and staying in the teaching profession.

Introduction

With the current shortage of science teachers nationwide, many K-12 school systems must hire applicants for science positions before the applicants are qualified in both teaching practice and content. In the Commonwealth of Virginia, these teachers are called "provisionally licensed," and they have three years to fulfill the requirements for licensure. Most provisionally licensed teachers hired to teach middle or high school science have a bachelor's degree in their content area. These provisionally licensed science teachers must plan and implement daily lessons and fulfill the other responsibilities of full-time teachers, all while developing strategies for successfully teaching their science content areas. They must perform these tasks with little or no training on how to teach effectively.

In the Commonwealth of Virginia, school districts are required to show student achievement in various ways, primarily through student scores on Virginia's *Standards of Learning* tests [1]. In Virginia, 70% of the students in a school must pass for a school to be

classified as "fully accredited." Research strongly supports the belief that well-prepared teachers are more likely to produce high achieving students [2-4]. For teachers to be well prepared and have the potential to produce high achieving students, they must not only know the content they teach, but they must also be skilled in classroom practice. Classroom practice is directly related to student achievement [5].

The depth and duration of preparation in teaching is an important factor in the number of years a teacher persists in the profession [4]. Five-year teaching preparation programs were the most successful at teacher retention, with only 16% of the graduates leaving the profession by the end of three years. Bachelor's degree-level licensure programs led to a dropout rate of 47%. The dropout rate continued to increase as the preparation duration diminished. In programs where teachers entered the profession through a short teacher training program, with a bachelor's degree and no license, the percent of dropouts was 66% by the end of the third year of teaching. This third category is the closest match to the provisionally licensed middle and high school teachers in our project. The teachers in the New Science Teachers' Support Network (NSTSN) received even less preparation to teach than this last category in the Darling-Hammond study [4]. If the study is predictive, we had the potential to lose more than 66% of our participants from the teaching profession by the end of the third year.

Provisionally licensed science teachers in Virginia must have a bachelor's degree in their subject area in order to teach, and there is no requirement that they have teacher training. They have three years to complete their license. In order to be fully licensed, they must be recommended by their school district (after one year of successful full-time teaching), complete certain coursework, and pass both Praxis I and II.

The New Science Teachers' Support Network

The NSTSN is a National Science Foundation-funded project developed to support provisionally licensed middle and high school science teachers. The goals are: 1) to support these teachers so they succeed at teaching; 2) to reduce the science teacher shortages in middle and high schools; and, 3) to conduct research on factors that contribute to retention and success. A component of the research focuses upon the teaching practices of new science teachers. The project is a four-year project funded for 2003-2007. Participants in the project are provisionally licensed middle and high school science teachers in two Virginia school districts. The total

number of participants at the conclusion of the project will be forty-five in the treatment group and forty-five in the control group. Fifteen teachers will be recruited for each group each year for three years. Teachers will participate in the project for two years, and data will be collected on all participants until the end of the project.

Pilot Study, 2002-2003

A pilot study for the NSTSN was run in the academic year 2002-2003, in partnership with two large northern Virginia school districts and funded by Eisenhower funds through the State Council for Higher Education in Virginia. The data from the pilot study provided information about provisionally licensed middle and high school teachers, and a foundation for hypotheses about effective support factors. There were four categories of support for the new middle and high school teachers who participated in the pilot year of the NSTSN. They were: the science methods course, the coach, the teaching mentor, and the academic mentor.

The Science Methods Course — In August, just a few weeks before they began their first year of teaching, the provisionally licensed teachers spent a full week beginning their coursework and preparing for teaching, under the guidance of their instructor. In the fall, the class met every other week. During the week in August and in the fall class meetings that followed, participants focused upon standards-based curriculum, inquiry-based lessons, authentic assessment of student understanding, reflective practice, and classroom management.

The Coach — The NSTSN provided an in-class coach for all participants during the pilot year of the project. This coach was usually a retired master science teacher, recommended by science specialists in the school district. Whenever possible, coaches were matched to teachers by subject. These coaches provided hands-on support while in the classroom with the provisionally licensed teachers. They co-planned and sometimes co-taught lessons. The coaches met with the teachers approximately one day each month of the academic year. Coaches provided help for many situations the new teachers faced. Some areas in which coaches provided advice and other assistance were for developing classroom and lab management strategies, planning short-term and long-term organization of standards-based course content, assessing student progress and achievement, and finding and creating teaching materials.

Teaching Mentor — These mentors are provided to all new teachers, meeting a requirement of the Commonwealth of Virginia. Mentors teach in the same school and are usually experienced classroom teachers who teach the same subject. They are usually chosen based upon their content knowledge, expertise in teaching, and collaboration skills. New teachers such as the middle and high school science teachers in this program, have access to this form of support on a daily basis as needed. Mentors can be available before and after school, during planning periods, and for "between-class" conversations. Mentors provide support to new teachers in the form of help with finding resources for teaching, providing information on school protocols, and providing teaching ideas.

Academic Mentor — Four faculty members at George Mason University were recruited to be academic mentors to the participants in the NSTSN. These faculty members were selected because they related well to future teachers, and their area of science specialty was the same as a licensure area for high school science teaching (earth science, biology, chemistry, or physics). Academic mentors met the provisionally licensed middle and high school science teachers during the summer week of classes and later, were available to the new teachers for questions about the science content through e-mail, telephone, or in-person meetings.

Demographics and Data Collection

Fifteen middle and high school science teachers participated in the pilot year 2002-2003 of the NSTSN project. Six of the teachers taught in middle school science classrooms, and nine taught high school science. Table 1 shows the distribution of teachers by grade level and science subject. There were more teachers hired to teach science without full licensure in the areas of physical science and physics, three and six, respectively, than in any other subject.

Table 1
NSTSN Pilot Year Cohort by Grade Level/Subject

Grade level	# of NSTSN Teachers
Sixth grade	1
Seventh grade (life science)	2
Eighth grade (physical science)	3
Earth Science	1
Biology	1
Chemistry	2
Physics	6

(Number > 15 due to teacher with more than one subject assignment)

In the pilot year of the NSTSN project, most of the teachers taught in high-minority schools, and in relatively high-poverty schools. When comparing schools that employed the group of teachers in the NSTSN with other schools in the two school districts, 79% of the participating schools had a higher percentage of minority students in their schools than was the overall average in the school district. Breaking down the data by middle school and high school teachers revealed a disturbing fact: 100% of the middle schools participating in the project had a higher percentage of minority students than the overall average in the school district. Thus, teachers with no training in how to teach challenging students were being placed in schools that served students speaking many languages and representing many different ethnic groups.

Multiple methods of data collection were employed in the research during the pilot year of the NSTSN. It was a mixed methods, quasi-experimental design. Teachers, coaches, and mentors all periodically completed surveys on various aspects of teaching. The coaches submitted e-mail observation reports after each visit with their teachers. Also, products from the science methods courses became artifacts for analysis: including lesson plans, analyses of videotapes of teaching, and reflection logs that included samples of students' work.

Qualitative data were collected, coded, and analyzed using the constant comparative process described by Glaser [6]. Many sources of information provided the basis for analysis, including monthly coach observations and surveys completed by coaches, teachers, and in-school mentors. Yin's cross-case synthesis methods were used to determine patterns and themes in the data set [7]. *NVivo* software was used to support the analysis of the large data set. Two raters independently analyzed the data using *NVivo* and inter-rater reliability was achieved through consensus building.

Findings

Self-Efficacy — During the pilot year of the study, self-efficacy was measured by the Teacher Self-Efficacy Scale [8]. The mean scores for self-efficacy varied by time of year, with the lowest mean occurring at midyear (see Table 2), indicating that participating teachers began teaching with a high level of self-efficacy/confidence. It is probable that their experiences the first semester of teaching contributed to the decrease in their self-confidence midyear. Their confidence went back up at the end of the year, but not as high as the beginning of the year.

Table 2
Changes in Self-Efficacy in Teachers in the NSTSN, 2002-2003

Time of Data Collection	Mean	Standard Deviations
Beginning of year	6.21	.85
Midyear	5.85	.84
Yearend	6.18	1.09

(N=15)

Teacher Competency — For each teacher, the corresponding coach completed two Summary Observation Reports. This instrument is the student teacher observation report form adopted by the Graduate School of Education at George Mason University. Coaches completed this form midyear and near the end of the academic year. Results from the two sets of data revealed significant improvement (p=<.05) in teacher competency measures.

Support Factors — At the end of the year, participating middle and high school teachers completed a survey that asked them to rank the support factors in the pilot project (course, mentor, coach) from 1-3 based upon effectiveness with 1 being most helpful (see Table 3). The basic science methods course was ranked as the most effective element in their support system, with in-school mentors a close second in rank. Coaches were ranked third. The differences in the means were not significant.

Teachers were asked why they ranked the support factors as they did, and the responses showed that all three support factors were important in the development of the teachers during their first year of teaching. One teacher commented:

> What we did in the George Mason course was very helpful, especially for me since I come from a different background. I know my content and I love teaching, but there are so many other things teachers need to know. You learn as you go on. I think that I'll never be able to teach every single student in my class at the same time, especially when there are thirty of them.

Another teacher noted that the in-school mentor was important: "Without my mentor last year, I would have been completely lost." The coaches were also perceived as being helpful,

especially in terms of instructional guidance: "My coach made me more aware of how to use good questioning style (wait time) and to set higher expectations for my students. Also, he gave me a practical strategy to get better classroom control."

Table 3
Teachers' Ranking of Support Factors

Support Factor	Mean	Standard Deviation
Course	1.78	. 97
Mentor	1.81	1.07
Coach	2.00	. 96

(*N*=15)

Planning and Teaching — During the pilot year of the project, middle and high school teachers showed improvement in their ability to reflect critically upon their own teaching. The reflection logs and coaches' observations revealed that teachers consistently focused on improving their own practice. In some cases, teachers reported that they "felt more inadequate than before," probably indicating that they were becoming more aware of what is expected of effective teachers and the difficulty of attaining this. This is also a sentiment consistent with the Bandura Self-Efficacy Survey results showing a decline in midyear in their confidence [8]. Teachers also gained skill in teaching special needs students and in using technology in the classroom.

Coach reports and coursework artifacts showed that the new middle and high school science teachers had difficulty establishing connectivity in their science lessons, day to day, from theme to theme, unit to unit, and in making connections from the curriculum to the lives of the students. Coaches reported that the new teachers were more concerned with planning daily lessons, and long-range planning was neglected.

Teachers used a limited range of instructional strategies and tended to persevere with those strategies with which they were comfortable, even when the strategy did not produce the desired student outcomes. One teacher continued to rely on writing on the whiteboard or blackboard when his coach had recommended using the overhead projector and facing the students. Another teacher had the tables in her classroom arranged in such a way that she could not easily navigate to the back of the classroom. Her table arrangement was discussed in class and the instructor for the course worked with the teacher and her classmates to develop

alternative arrangement ideas for this teacher (some of which were drawn out for her). Nonetheless, when her coach subsequently visited her classroom, the tables still blocked the back of the room. It took the direct action of the coach to finally alter the table arrangement in this essential manner. The teacher then stated that she finally understood what to do, and that it had proven very helpful to move the tables so that she could move among the students more easily.

Classroom management was a challenge for most teachers. Coaches noted that there were students in some of the science classrooms who perpetually remained off task. When this occurred, the middle and high school teachers in those classrooms were only moderately successful in using the coaches' suggestions for altering student behaviors.

The teachers had good rapport with their students, as reported by coaches. Students would come to talk to teachers during class breaks, for advice and conversation. One teacher received a drawing depicting her as the "Best Teacher in the World."

Professional Development — Many of the middle and high school teachers in the project took the new teacher training offered by their school district, in addition to the graduate level science methods course they took as part of the NSTSN. Several committed to the Master's of Education program at George Mason University, even though this was not a requirement for licensure. This was a further indication that the teachers perceived that the coursework was helping them with teaching.

Factors that Supported Success — All the forms of support that were part of the NSTSN had a positive effect on teacher performance. From the coursework, teachers learned multiple teaching strategies, including inquiry-based instruction and continuous assessment. They also learned how to plan and adapt their teaching for diverse classrooms. Teachers learned how to develop and use scoring rubrics in assessment. The use of scoring rubrics—specific guidelines for student performance—is an aspect of science education reform that supports inquiry-based teaching. The new teachers also learned ways to apply new technologies in their science classrooms.

Because coaches were present in the classroom and could give immediate feedback, they provided ideas for teaching organization, materials, and the classroom that were specific to the individual teacher. Coaches contributed to teacher success by being able to give immediate

constructive feedback in the classroom while the lesson was being taught, or very soon afterward. In addition, the coaches assisted with planning future lessons.

Retention of Teachers — All of the fifteen teachers who participated in the pilot study returned to teaching the next year. One of the strongest of the beginning teachers expressed her intention to leave the area for economic reasons. She did leave the school district, and is currently teaching middle school science in another Virginia district about one hundred miles away. She says she will not teach after 2003-2004. A second particularly strong beginning teacher voiced many frustrations at the close of the academic year about the lack of professional recognition and the burden of the responsibilities of teaching. Though it appeared he might leave teaching, this second teacher returned to teaching in the fall, along with the fourteen other teachers in the project. Thus, all of the fifteen teachers in the pilot year of the NSTSN remained in teaching.

Conclusion

Self-Confidence — The results from the self-efficacy measurement indicate that teachers enter the profession with a high level of self-confidence. The decline in self-efficacy midpoint in the pilot year indicates that the experiences of the first semester of the first year of teaching brought a "reality check" to the expectations of these provisionally licensed teachers. Also, the basic science methods course exposed participants to the goal of providing authentic inquiry-based experiences, which may have shown these beginning teachers that there was more to teaching science than they believed prior to taking this course. In addition, the basic science methods course required participants to videotape themselves teaching in their own classrooms. They showed excerpts of the videotapes in the class, analyzing their teaching and receiving feedback from their classmates and instructor. All of these coursework experiences served to point out, not only areas of strength, but also areas where improvement was needed.

The increase of self-confidence back near beginning levels by the end of the school year may be an indication of confidence as an outgrowth of practice. By the end of the academic year, these teachers had taken at least one science methods course, and had experienced the support of their in-school mentor, and regular visits and the support of their in-classroom coach. Their coaches gave them regular feedback about what they were doing well and where they needed to improve, and the participating teachers no longer had to depend upon their own naïve assessments of what is good teaching.

Teacher Practice — It was clear from the qualitative information and the statistical results from the Summary Observation Report that the participating beginning teachers learned and applied many ideas gleaned from their coursework, mentors, and coaches. This is good news for most school districts in the United States, since each year most school districts must now hire at least some science teachers who are not fully licensed. Though most of the teachers in this project were career switchers, and some were experienced in teaching adults in military and business settings, they were amenable to self-reflection and new ideas. Though there were some areas where the beginning teachers had difficulty becoming skillful, such as establishing connectivity and increasing their repertoire of teaching and classroom discipline strategies, the teachers became more successful as the project progressed.

Ideas that were adopted by the teachers and applied in the classroom tended to be those that were practical and applicable in the short term. Coaches reported that teachers used activity ideas they had practiced and discussed in their methods course. However, the teachers generally failed to fully implement inquiry-based, hands-on instruction even when supported by a multifaceted system of mentors and coursework. It may be that the first level of beginning teacher support for provisionally licensed teachers should be at a very practical level, with the expectation that the teacher will soon "graduate" to practices that are consciously seated in practices recommended in science education research, such as problem-based, student-centered instruction.

The Duration of Support — The provisionally licensed science teachers in this study made significant progress, yet had much further to go to become highly skilled teachers of science. The support mechanisms implemented in this project were substantial, indicating that there is only so much new teachers can try in the first years of teaching. For an enduring shift in teaching approaches, one year of mentoring and coursework was not enough. Some teaching strategies, such as using many and in some cases any, hands-on activities, proved too daunting for new teachers, and the coaches observed a pattern of traditional approaches to instruction. As indicated by the teachers' own assessment of the effect of the various support mechanisms, all forms of support were helpful. However, they indicated that the coursework had the greatest impact. These three support factors should be extended and amplified if school districts expect to benefit from science teaching practices that promote the achievement of all students.

Teacher Retention — It was encouraging that after the pilot year of the study, all of the teachers remained in the profession. The results from the pilot study indicated that the interventions in the project were effective in retaining science teachers in the profession. However, the short duration of the pilot was not sufficient to provide information about retention beyond one year. Retention is an issue beyond the first year of teaching.

Recommendations

The forms of support explored in the pilot year of the New Science Teachers' Support Network were effective with beginning teachers who had no prior education background. Coursework that emphasizes preparation for teaching and reflective practice should be connected with a school-based support system. Also, support should be extended beyond one year. The next phase of the NSTSN will provide two years of support to participants in the treatment group. Participants will take the advanced science methods course, and coaches will visit participants during the second year of teaching. Data will be collected for two years about the teaching practices of the new teachers, and researchers will be able to draw conclusions about the impact of the longer intervention on the skills of the new teachers. Retention data will be collected for four years.

One major flaw of the pilot study was the lack of a comparison group. It is possible that all of the changes seen in the participants were due to maturation as teachers. The second phase of the project includes a control group for each year that a treatment group participates in the project. Thus, there will be more confidence at the conclusion of the study as to whether the results are caused by the intervention of the support factors in the NSTSN.

Whatever is learned about the impact and duration of support for provisionally licensed science teachers, the need to hire these under-qualified teachers will continue for at least the short term. Therefore, school districts must determine how best to provide support, for the purpose of improving teacher skill and student achievement. School districts must also consider the impact of support on teacher retention, and hope that there are support factors and practices that can alter the pattern of 66% or more dropouts from teaching by the end of the third year.

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References

[1] *Standards of Learning for Virginia Public Schools*, Board of Education, Commonwealth of Virginia, Richmond, VA, 1995.

[2] L. Darling-Hammond, *Teacher Quality and Student Achievement: A Review of State Policy Evidence*, Center for the Study of Teaching and Policy, University of Washington, Seattle, WA, 1999, Internet: http://depts.washington.edu/ctpmail/PDFs/LDH_1999.pdf.

[3] L. Darling-Hammond, "Teacher Quality and Student Achievement: A Review of State Policy Evidence," *Educational Policy Analysis Archives*, **8**(1) (2000).

[4] L. Darling-Hammond, "Keeping Good Teachers: Why It Matters, What Leaders Can Do," *Educational Leadership*, **60**(8) (2003) 6-13.

[5] H. Wenglinsky, *How Teaching Matters: Bringing the Classroom Back into Discussions of Teacher Quality*, Educational Testing Service, Princeton, NJ, 2000, Internet: http://www.ets.org/research/pic/teamat.pdf

[6] B. G. Glaser, *Theoretical Sensitivity: Advances in the Methodology of Grounded Theory*, Sociology Press, Mill Valley, CA, 1978.

[7] R.K. Yin, *Case Study Research: Design and Methods*, Sage Publications, Thousand Oaks, CA, 2003.

[8] A. Bandura, *Self-Efficacy: The Exercise of Control*, W.H. Freeman and Co., New York, 1997.