# The Influence of a Two-Year Professional Development Institute on Teacher Self-Efficacy and Use of Inquiry-Based Instruction


## Abstract

This paper investigates the impact of a two-year professional development program on teacher self-efficacy for inquiry-based instruction. The program utilizes scientist-teacher partnerships to develop content knowledge, inquiry-based instruction, and leadership skills for in-service STEM teachers. Participating teachers are administered a survey to assess their self-efficacy at the start and completion of the program. The findings suggest increases in self-efficacy for inquiry-based instruction and greater focus by the teachers on the depth of content after completing the program. The results substantiate prior research conducted on the benefits of teacher participation in professional development utilizing a scientist-teacher partnership model. Other trends in the data, future research, and implications for the design or refinement of professional development programs are discussed.


## Introduction

Over the past two decades, numerous national reports on the need for reform in education have focused on the concomitant need for reform in science, technology, engineering, and mathematics (STEM) education. Reports such as *A Nation at Risk (*National Commission on Excellence in Education, 1983*)*, *Rising Above the Gathering Storm (*National Academy of Sciences, 2007*)*, and *Before It's Too Late* (Glenn, 2000) all advocated for curricular changes and better teacher preparation in STEM education.

**Keywords:** inquiry-based instruction, professional development, teacher self-efficacy, scientist-teacher partnerships

Recent international comparative research shows that U.S. students lag behind their international counterparts in STEM subjects (Kuenzi, 2008). In 1996, the National Science Foundation put forth a recommendation that inquiry-based instruction needs to be encouraged and used more frequently in STEM classrooms to transform science and mathematics education in the U.S. (National Research Council, 1996). Indeed, research has shown that students taught using inquiry-based instruction perform better than students taught in more traditional ways (Yagar & Akcay, 2010).

## Use of Inquiry-Based Instruction in the Classroom

Inquiry-based instruction starts with teachers who "encourage and model the skills of scientific inquiry, as well as the curiosity, openness to new ideas, and skepticism that characterize science" (National Research Council, 1996, p. 37). Inquiry-based instruction can be explained as "engaging students in the cognitive processes used by scientists" (Crawford, 2000, p. 934). This engagement occurs through the development of research questions and methodology and through the formation, testing, and refinement of hypotheses and theories (Crawford, 2000). Inquiry-based instruction "calls for relatively high content knowledge, understanding of the elementary students' learning styles, the planning and use of multiple teaching strategies, and a supportive environment" (Bhattacharyya, Volk, & Lumpe, 2009, p. 213). Both teachers and students in an inquiry-based classroom take on a number of roles that require a high level of expertise not found in traditional topic-centered classrooms (Crawford, 2000).

Unfortunately, Kim and Fortner (2007) assert that professional teacher preparation has not provided teachers with the necessary knowledge of scientific processes and professions to attain this level of expertise. Research also suggests that "science teachers are concerned about their ability to apply a novel teaching method and about the adequacy of their own professional training in science content and science teaching" (Bhattacharyya et al., 2009, p. 202); these concerns are especially prevalent with elementary teachers. Teachers often report a lack of direct research experience during their pre-service training; science for many teachers is attained from textbooks (Dresner & Starvel, 2004).

In-service teachers also demonstrate misconceptions of inquiry-based instruction, often equating hands-on science instruction with inquiry-based instruction (Crawford, 2000). The danger in this misunderstanding is that hand-on science instruction often provides students with a series of tasks and activities that are not connected substantively to the content being taught. In addition, these hands-on tasks often are not based on the theories of student learning that drive inquiry-based instruction. Compounding this potential inadequacy of training, novice teachers are also "challenged with balancing theory with practice acquired through experience" (Onofowora, 2004, p. 34). This challenge is precipitated by "the transition

from learning about teaching theory, to a brief teaching internship that prepares individuals to teach, but the 'mastery' of teaching and instructional effectiveness is likely to occur several years into the teaching practice" (Onofowora, 2004, pp. 34-35). Thus, novice and experienced teachers without the necessary preparation in scientific process and/or content or accurate knowledge of inquiry-based instruction are less apt to employ inquiry-based instruction in their classrooms. As a result, teachers may have lower-levels of self-efficacy, thereby further reducing the use or attempted use of inquiry-based instruction in the classroom.

## Development of Self-Efficacy

Bandura (1993) defined self-efficacy as a self-referent phenomenon that influences how a person constructs and selects his environment. Self-efficacy is therefore a mechanism of agency. It is a person's belief about his/her abilities, specifically "about their capabilities to exercise control over their own level of functioning and over events that affect their lives" (Bandura, 1993, p. 118). Tschannen-Moran, Hoy, and Hoy (1998) expand on this definition as "a future-oriented belief about the level of competence a person expects he or she will display in a given situation" (pg 210). It is the "self-perception of competence rather than the actual level of competence" (Tschannen-Moran et al., 1998, p. 211). Furthermore, Tschannen-Moran et al. (1998) explain self-efficacy, specifically teacher efficacy, as a motivational construct. Therefore, teachers with lower levels of efficacy will be less motivated to put forth effort during instruction and will show lower levels of persistence. It is important to note that teacher efficacy is not an all-or-none concept; teachers can have different levels of efficacy between and within content areas.

Teachers with a greater sense of instructional efficacy spend more time attending to student learning, provide more support to students with learning difficulties, and give students more praise; in contrast, teachers with a lower sense of efficacy spend less time on learning, offer less time to students with learning difficulties, and provide more criticism (Gibson & Dembo, 1984). Teachers with low efficacy in the teaching of science often lack motivation and effectiveness, display lower levels of content knowledge, and teach less effectively in the classroom (Bhattacharyya et al., 2009). By comparison, students of teachers with greater efficacy demonstrate greater mathematic and language achievement (Ashton & Webb, 1986; Allinder, 1995). Thus, efforts to increase teacher efficacy, along with improved content knowledge and understanding of scientific processes, will also increase teacher effectiveness and student performance.

## Significance of Scientist-Teacher Partnerships

Among pre-service teachers, McDonnough and Matkins (2010) found that teachers who participated in field experiences embedded within a science methods course increased in their self-efficacy (see also Bhattacharyya et al., 2009). However, pre-service teachers who participated in a teaching practicum not connected to a methods course did not show increases in their self-efficacy for teaching science. The embedded field experiences included the development and teaching of science lessons, whereas the free-standing practicum consisted of field experiences in science, mathematics, and social studies. Furthermore, the teachers with the embedded field experience also showed "greater understanding in research-based science teaching practices" (McDonnough & Matkins, 2010, p. 13). The authors postulate that supervision by content experts and their support in connecting research to practice make the embedded field experience more effective than the free-standing practicum.

Among in-service teachers, professional development has long been shown to improve teacher performance in the classroom. As part of the National Science Standards set forth by the National Research Council in 1996, professional development in which teachers engage in research is considered an integral part of reform efforts in science education. Professional development programs that focus on how students learn specific content in science and mathematics produce greater effects on student learning than programs that focus on teacher behavior (National Institute for Science Education, 1999).

In fact, in-service teachers see direct benefits when scientist-teacher partnerships associated with professional development are used to develop content knowledge, along with scientific process and research skills through collaboration on research projects. Professional development utilizing investigated scientist-teacher partnerships increased understanding and use of inquiry-based instruction by participating teachers (Caton, Brewer, & Brown, 2000; Dresner & Moldenke, 2002). Teachers involved in these partnerships also develop deeper content knowledge, greater knowledge about laboratory investigation, and better capabilities for integrating experiments with the curriculum (Siegel, Mlynarczyk-Evans, Brenner, & Nielsen, 2005). Additionally, participating teachers reported the increased use of hands-on or laboratory activities along with the development or revision of content in their lessons or laboratories, greater introduction of new technologies, and an increase in requirements for assignments (Silverstein, Dubner, Miller, Glied, & Loike, 2009).

Dresner and Worley (2006) found that scientist-teacher partnerships allowed teachers to sustain classroom-reform efforts, while increasing their knowledge and skills and changing their teaching methods. These partnerships also helped participating teachers throughout the school year through the continued involvement of scientists as reference sources or classroom visitors. Furthermore, Weisbaum and Huang (2001) found that teacher participation in these programs not only increases subject-area knowledge and knowledge of technology, but also teacher leadership as evidenced by movement into leadership roles after completion of the program (see also Silverstein et al., 2009).

Participating teachers also show increased confidence in their level of

knowledge and scientific fieldwork and in their understanding and use of inquiry-based teaching of science (Dresner & Moldenke, 2002). Professional development that involves scientist-teacher partnerships focused on inquiry has also shown increases in teacher perceptions of their growth in content knowledge and scientific process understanding, as well their confidence and self-efficacy in their understanding and teaching of the scientific content (Morrison & Estes, 2007).

In addition to the direct impact on teachers, students also benefit when their teacher participates in a scientist-teacher partnership. Student performance and inquiry skills have shown increases as a result of their teacher's involvement in the research project (Desner & Moldenke, 2002; Silverstein et al., 2009). Specifically, Silverstein et al. (2009) found significant increases in student achievement on high-stakes tests among students whose teachers participated in a two-year summer research program. Research suggests that the scientist-teacher collaboration leads to a deeper "conceptual understanding and increased motivation on the part of the students" (Dresner & Worley, 2000, p. 12).

## The Kenan Fellows Program

The Kenan Fellows Program is a two-year program engaging educators in intensive professional development in science, technology, engineering, and mathematics (STEM) education. The program's primary goals are to increase STEM teacher leadership and develop cutting edge inquiry-based curricula through scientist-teacher partnerships, research externships, and summer professional development institutes. To assess program impact on the Kenan Fellows, the program undergoes an independent formative evaluation each year. The 2008 cohort of Kenan Fellows was assessed at the beginning and end of the program to investigate changes their self-efficacy pertaining to inquiry-based instruction and inquiry-based behaviors. Further investigations look at the program's impact on its Fellows by assessing perceived self-efficacy (pre- and post-program) in the use of inquiry-based instruction and related behaviors and beliefs. Also of interest in the effects of participation in the Kenan Fellows Program are relationships between participant characteristics and any differential effects on perceived self-efficacy or inquiry related behaviors and beliefs. These differences, if found, have the possibility to suggest programmatic changes to increase the impact on teacher effectiveness and curriculum development.

**Program Description.**

In 2000, community members of North Carolina's Research Triangle area created this two-year fellowship to reduce STEM teacher loss in North Carolina and to develop cutting-edge and relevant curriculum to increase student enthusiasm and interest in STEM courses and careers across the state. To address these issues, the Kenan Fellows Program provides intensive professional development to educators through summer externships with industry and university scientists (Kenan Fellow mentors) and professional development institutes. The program, which is supported by grants from foundations, government organizations, corporations, and individual partners, is located at North Carolina State University and housed in the Kenan Institute for Engineering, Technology, and Science.

The intensive professional development offered by the Kenan Fellows Programs is designed to fulfill specific program goals: 1) to develop and retain STEM teacher leaders, 2) to advance effective 21st century teaching skills, 3) to develop relevant STEM K-12 instruction and best practices through the partnerships of teachers and scientists, and 4) to develop a curriculum project that is an innovative and relevant curricular resource for other STEM educators. The Kenan Fellows Program attempts to identify and retain qualified teachers, while fostering curriculum development and leadership skills through professional development based on the needs of North Carolina students and derived from national standards and current research in order to impact student achievement in STEM areas.

This competitive program invites applications each spring from K-12 teachers and educators from across the STEM disciplines who are interested in the advancement of STEM education. Kenan Fellows are then selected by a panel of reviewers consisting of educators from the North Carolina Department of Public Instruction, North Carolina State University faculty, Kenan Fellows mentors, and the program staff. Part of the selection process matches the applicants to university or industry scientists who will serve as Kenan Fellow mentors during the two-year program, which begins the following summer.

During the summer portions of the Kenan Fellows Program, Kenan Fellows complete an externship followed by a professional development institute. The first summer of the program consists of a four-week externship overseen by Kenan Fellows mentors and a two-week summer professional development institute. The second summer of the program includes a five-week externship and a one-week summer institute. Throughout the two school years, Fellows attend special seminars and events; participate in regional or national conferences; attend meeting sessions (called Fireside Chats) with government, education, or business leaders who are influential in education public policy; and pilot and refine a curriculum project in their classrooms. Mentors also visit as guest instructors or presenters in their Fellows' classrooms.

During these two summers, Kenan Fellows work with their mentors through an externship either in a corporate or university laboratory setting to develop a curriculum project, which focuses on inquiry-based learning and enriches their content knowledge. The mentors' roles overseeing the externship are typically to provide experiences and insight into research, coaching in STEM content, and, when applicable, laboratory and resource access. Externships can take place in a variety of settings and range from fieldwork in other countries to laboratory studies at universities and corporations to specialized content

experiences at museums, conservatories and planetariums.

The curriculum for the Kenan Fellows' Summer Professional Development Institutes focuses on the use of inquiry-based instruction and the development of teacher leadership skills. During these institutes, Fellows also learn about global and local, current and future needs in STEM education and careers, as well as how to engage students in 21st century technology usage. Fellows discuss the impact of technology on underprivileged student populations and on students in general, along with the importance of and rationale behind teacher standards to prepare students for STEM careers. Kenan Fellows also focus on best practices in teaching STEM education and learn about effective communication with the public, parents, colleagues, and students.

The externships and summer institutes are designed to give Fellows the content knowledge and experiences needed to develop a curriculum project that will advance STEM curriculum in North Carolina and beyond. The K-12 curriculum projects are designed to emphasize inquiry-based learning and to apply academic knowledge and research to authentic, real-world problems. The partnership of scientists within industry and institutions of higher education with public school educators, utilizing a mentor-mentee paradigm, makes the development of these projects possible. An independent team of STEM experts assess each curriculum project to further ensure relevancy and content before materials are made available to teachers through the Kenan Fellows website.

As an example, knowing that many students are interested in speed racing, one Kenan Fellow and her mentors delved into the world of automotive racing to find ways to teach middle school students science and mathematics concepts. The final curriculum project explored multiple science and mathematics concepts using racing as its theme.

During the first externship, the Kenan Fellow and her two mentors (an extension and outreach scientist and an engineering and design professor) explored which concepts in automotive racing could be translated to the middle school classroom. A national racing company, along with their research and development department, and two racing teams invited the Fellow to meet with their scientists and engineers to discuss current trends in racing and the science behind these trends. From these discussions and from their exploration of the field of racing, the Kenan Fellow and her mentors began to create potential science and mathematics lessons.

During the following school year, the Kenan Fellow and her mentors focused their lessons on the science and mathematics of safety issues surrounding automotive racing. At this point, an additional (unofficial) mentor with expertise in automotive accidents and accident reconstruction joined in developing the curriculum project.

The second summer externship consisted of developing the units in detail, as the Fellow and her mentors tried out many of the potential study units. They continued to refine the lessons over the course of the next year as the Fellow tested concepts in her classroom, made sure all details were accurate, and translated the steps for teachers and middle school students.

The final curriculum project introduces students to the science and mathematics of safety in the automotive racing industry. For example, one of the units pertains to understanding compounds and textiles involved in fire retardation. Students dip different fabrics into various compounds, taking measurements of how well the compounds retard fire by observation and comparison with a water treated fabric and connecting their findings to drivers' uniforms. In other units, students design rides and courses in order to prevent injury in the event of a crash or design a vehicle from which it takes less than 30 seconds to remove the driver. Students utilize barriers and protective equipment to minimize injury to their drivers (portrayed, in this case, by eggs). Other units include using the mathematics behind racing to teach concepts such as slope, proportion, arc, radius, and circumference.

After the two-year program, Fellows are expected to take on greater roles in their schools and the broader community to promote collaboration and to strengthen STEM education. Each Kenan Fellow is expected to attend and present at a professional conference during and following their participation in the program. Fellows are also expected to give professional development training within their schools based on their research experiences and their curriculum project. Upon completion of the Kenan Fellows program, Fellows receive six graduate level course credits from the Curriculum and Instruction Program in the Department of Education at North Carolina State University

## Method

### Participants.

To be accepted into the Kenan Fellows Program, Fellows must be active classroom teachers who express interest in advancing STEM education. The program is designed for elementary, middle, and high school teachers in North Carolina public schools, including charters schools and traditional public schools. Although the program is designed to provide professional development seminars and externships during the summer, teachers in year-round schools are accepted with special consideration.

Thirty-one Fellows were accepted into the Kenan Fellows Program for the 2008 cohort. After the first year of the program, five Fellows decided not to continue with the program. An additional three Fellows did not complete the research instrument under investigation after the second year of the program. Because these eight Fellows have been excluded, this study will include the 23 Fellows who completed both the pre- and post-program survey instrument.

The aim of this study is: 1) to assess the impact of a professional development program, specifically the Kenan Fellows program, utilizing a scientist-teacher partnership to develop teacher content knowledge and leadership on teacher behaviors and beliefs pertaining to inquiry-based instruction and 2)

to determine what, if any, participant characteristics mediate this impact. An adapted version of the survey instrument used by Marshall, Horton, Igo, and Switzer (2009) was administered to each Fellow at the beginning of the first year of the program (pre-survey, summer 2008) and end of the program (post-survey, spring 2010) to determine changes in behaviors and beliefs and to capture related demographic variables. The survey instrument administered to Kenan Fellows included only those questions from the Marshall et al. (2009) survey instrument relevant to self-efficacy and inquiry-based behaviors and beliefs, in addition to demographic and other participant characteristics with potential effects on self-efficacy, beliefs, and behavior. The demographics and survey instrument are administered to all Fellows online.

## Measures

Research measures included demographics; self-efficacy; administrative, faculty and curricular support; and inquiry-based behaviors.

**Demographics.**

At the start of the Kenan Fellows Program, the following background demographic variables are collected: ethnicity, gender, number of years teaching, subject matter taught, grade level(s) taught, and prior attainment of advance degree. The survey instrument also captures prior STEM career before teaching.

**Self-Efficacy of Inquiry-Based Instruction.**

The Marshall et al. (2009) survey instrument consisted of four questions to ascertain the level of self-efficacy for inquiry-based instruction. When presented with statements related to their beliefs about their effectiveness in implementing inquiry-based instruction in the classroom, Fellows are asked to rate their agreement with the statements based on a six-point Likert-type rating scale (1 = completely disagree, 2 = strongly disagree, 3 = disagree somewhat, 4 = somewhat agree, 5 = strongly agree, and 6 = completely disagree). These four items are summed to yield a composite efficacy score, ranging from four to 24.

**Administrative, Faculty, and Curricular Support for Inquiry-Based Instruction.**

Administrative, faculty, and curricular support for the use of inquiry-based instruction are measured with the Marshall et al. (2009) survey. Administrative and faculty support were summed together to yield a composite school-level support score, while curricular support was kept separate since Marshall et al. (2009) found that the question asking if the curriculum supports inquiry was different than asking if administration and faculty support of inquiry.

**Inquiry-Related Behaviors.**

The survey also asks questions pertaining to teacher beliefs and perceptions about the use of inquiry-based instructions.

## Results

**Demographics and Cohort Descriptives.**

Twenty of the 23 Fellows identify their ethnicity as white, while two Fellows identify themselves as African-American and one as other. The 2008 cohort includes 17 females and six males.

The majority are high school teachers ($N$=17, 61%). Two of the Kenan Fellows are elementary educators and the remaining seven are middle school teachers. Eighteen Fellows indicate that they teach science subjects or courses exclusively. One Fellow teaches both science and mathematics courses. Three Fellows teach only mathematics. One Fellow teaches all subjects in a general elementary classroom.

The majority of the Kenan Fellows attained an advanced degree before acceptance into the program ($N$=13, 56.5%). Nine (40%) of the Fellows worked in a science, mathematics, technology, or engineering career prior to teaching. The mean number of years a Fellow taught prior to the program was 8.6 ($SD$=5.0, $Mdn$=8.0).

**Self-efficacy of inquiry-based instruction.**

According to a paired t-test analysis, Kenan Fellows at the end of the program's second year indicated increased self-efficacy using the composite score in inquiry-based teaching ($t(22)= -2.81$, $p<.05$). Of the individual questions in the composite, all showed a significant increase from the beginning of the program to the end, except for the question pertaining to managing behavior during inquiry based instruction ($t(22)=-1.25$, $p=.22$).

**Administrative, Faculty, and Curricular Support for Inquiry-Based Instruction.**

Kenan Fellows in the 2008 cohort indicated consistently high levels of support from their administration and other faculty both before and after the program ($Mpre$=9.4, $SDpre$=2.0; $Mpost$=9.4, $SDpost$ =1.5). Using a paired sample t-test, the level of support did not show significant changes. The 2008 cohort also indicated a high level of agreement that their curriculum allows for the use of inquiry-based instruction ($Mpre$=4.5, $SDpre$=1.0; $Mpost$=4.6, $SDpost$ =1.3). Again this change was not significantly different from the beginning to end of the program using a paired-sample t-test.

**Inquiry-Related Behaviors.**

The survey instrument asks ten questions related to teaching behaviors often used during inquiry-based instruction. Of these 10 questions, only two revealed significant changes between the first and the second year. Fellows indicated that, after the second year of the program, they agreed less with the statement that *it is more important to teach all course objectives than to teach key concepts in depth* ($M$=3.4) than they did at the beginning of the program ($M$=2.7) (t(22)=2.34, $p<.05$). Fellows after the second year ($M$=5.3) indicated significantly less agreement with the statement regarding the *importance of helping students see the connections between science/math and other subjects* than at the beginning of the program ($M$=5.6), using a paired sample t-test ($t(22)=2.24$, $p<.05$).

**Related Factors.**

The number of years teaching positively correlates with pre-efficacy scores ($r(21)=.46$; $p<.05$), but does not correlate with post-efficacy scores ($r(21)=-.06$; $p=.77$). After the second year of participation in the Kenan Fellows Program, the number of years a Fellow has been teaching is significantly and negatively correlated with the amount of time they participate in inquiry in their classroom ($r(21)=-.43$, $p<.05$). There was no correlation between years teaching and the amount of time they participate in inquiry-based instruction at the beginning of the program; however, teachers with fewer years in the classroom were more likely to increase their use of inquiry-based instruction after the second year.

Fellows' demographic and participant characteristics were also analyzed to see if there is an influence on pre- and post-program efficacy scores and on pre- and post-program ideal inquiry. Gender, attainment of an advanced degree prior to participation in the program, and having a STEM career prior to teaching were included in the analysis. A repeated-measures ANOVA was used to test for significant changes in scores before and after participation in the Kenan Fellows program and to test for differences in these changes by participant characteristics. A Fellow's gender and his/her completion of an advanced degree did not have differential effects on pre- or post-program efficacy score changes or changes in ideal use of inquiry in the classroom. However, there were differences in the change in efficacy scores if a Fellow had a STEM career prior to teaching. These two groups (Fellows without a STEM career prior to teaching and Fellows with a STEM Career prior to teaching) were not significantly different at the start of the program ($M=19.0$, $M=19.3$, respectively). Fellows without a prior STEM career had marginally higher change in efficacy scores than Fellows with a prior STEM career at the end of the program ($M=22.1$. $M=19.7$, respectively, $p>.05$).

## Conclusion and Discussion

The teachers who participate in the Kenan Fellows Program are highly motivated to advance STEM instruction. However, the results of this study reveal interesting trends in in-service teachers' use of inquiry-guided instruction before and after their participation in a professional development program that focuses on the development of content knowledge and leadership through scientist-teacher partnerships. After participation in the program, Fellows indicate increases in their self-efficacy for inquiry-based teaching and greater focus on the depth of content than on the coverage of all course objectives. The results of this study further substantiate prior research conducted on the benefits of teacher participation in this type of professional development programs as a way to increase teacher use of inquiry-based instruction and self-efficacy pertaining to its use (see Dresner & Moldenke, 2002; Morrison & Estes, 2007). This research also supports calls for increases in such professional development to improve STEM education (Kim & Fortner, 2007; Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003).

Interestingly, the number of years a Kenan Fellow has been teaching is positively correlated with a Fellow's self-efficacy score at the beginning of the program but not their self-efficacy score at the end of the program. In contrast, no correlation was found between the number of years teaching and the amount of participation in inquiry-based instruction at the beginning of the program. However, at the end of the program, the number of years a Fellow had been teaching was negatively correlated with the amount of time Fellows participate in inquiry-based instruction in their classroom.

These findings point to the possibility that content knowledge and research skills gained from participation in the program increase the self-efficacy of more novice teachers to the level of more experienced teachers. This gain in self-efficacy along with content knowledge and research skills may provide the impetus for these more novice teachers to use inquiry-guided instruction in their classroom more frequently. Perhaps significant changes in teachers' practices will occur after a period of time instead of immediately upon the completion of the program (Dresner & Worley, 2006). However, since more novice teachers are still developing their teaching practices, the program potential has more of an immediate effect on their classroom behavior.

Another interesting trend in the data is the relationship of having a STEM career prior to teaching to the efficacy score at the beginning and end of the program. At the beginning of the program, the two groups of Fellows are equivalent in their efficacy score. However, at the end of the program, Fellows without a prior STEM career showed a greater, though nonsignficant, increase in their efficacy score than Fellows with a prior STEM career.

This result leads to the question of what teachers are using to determine their self-efficacy for inquiry-based instruction. One possibility is that teachers without a prior STEM career initially judge their self-efficacy based on their pedagogical knowledge; subsequently, after completion of the program, these teachers may judge their self-efficacy based on their increased content knowledge as well as pedagogical knowledge. If true, this answer indicates that the content knowledge gained from program experiences is the primary determinant behind the increase in self-efficacy for teachers without prior STEM careers. Conversely, this finding may indicate that professional development programs should focus on furthering both content knowledge and pedagogy for lateral entry teachers coming from STEM careers in order to increase their self-efficacy in the use of inquiry-based instruction. This question warrants further investigation.

This research suggests specific ways to provide and improve professional development for teachers in order to positively impact education quality. Professional development like the Kenan Fellows Program—that cultivates partnerships between scientists and teachers

in which they work in to develop content knowledge through research experiences—benefits both the participating teachers and their students. The research discussed here identifies a potential need for differentiated professional development for both traditional-path and lateral-entry teachers and for both novice and experienced teachers.

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