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Math and Science Mid-career Entrants to Teaching:

Well Skilled but "Working in a Void"

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INTRODUCTION

In 1957, the Soviet launch of Sputnik-1 prompted many Americans to conclude that the U.S. was no longer the world leader in technological innovation (McDougall, 1997). Politicians and education reformers pointed to the inadequacies of math and science public education as having contributed to the United States' fall from grace (Flynn, 1995); they argued that improving math and science education was imperative if the U.S. were to preserve its general welfare and regain the technological ground it had lost. Since that time, panels of experts[1] have repeatedly been convened to investigate the status of math and science education. In nearly every instance, these panels have issued reports that depict troubling trends—foreshadowed by sensational titles like *Rising Above the Gathering Storm* (National Academies, 2005) and *Before It's Too Late* (NCMST, 2000)—and urge policymakers to act immediately or face dire consequences.

In response to these reports, education reformers have launched numerous initiatives to strengthen curricula, attract qualified teachers, and channel technological resources to math and science classrooms.[2] Despite these initiatives, U.S. student performance on math and science assessments remains lackluster, some say dismal. Darling-Hammond reported that, on the 2003 Program in International Student Assessment (PISA) examination, U.S. fifteen-year-olds, "ranked 28th out of 40 countries

[1] Investigatory panels have been comprised of Nobel Prize winners, scholars, politicians, educators, and private sector magnates.

[2] For example, the National Research Council created the National Science Education Standards—standards on the content, pedagogical strategies, assessments, and teacher professional development efforts required to improve science education. President George W. Bush's 2006 American Competitiveness Initiative allocated $25 million towards the creation of an Adjunct Teacher Corps—30,000 math and science professionals who would work in classrooms part-time. Apple Computer has forged relationships with U.S. states and districts to make math and science education more interactive through the use of sophisticated "mobile learning labs."

in mathematics—on par with Latvia—and 20th in science," right after Iceland (Darling-Hammond, 2007, p. 2). On recent national assessments, such as the National Assessment of Educational Progress (NAEP), only about one-third of U.S. students typically receive marks in math and science that are "Proficient" or better; another one-third usually score below the "Basic" standard (NCMST, 2000).

Unfortunately, the bad news regarding math and science instruction does not end with test scores. The shortages of qualified math and science teachers that were identified decades ago persist. Numerous researchers and investigatory panels (e.g. Strizek, G. A., Pittsonberger, J. L., Riordan, K. E., Lyter, D. M., & Orlofsky, G. F., 2006; AAEE, 2005; Ingersoll, 2000; Murnane, Singer, Willett, Kemple, & Olsen, 1991) have found that schools struggle to attract and retain qualified math and science teachers and that alarming numbers of math and science teachers are underqualified. Of the public secondary schools with teaching vacancies in 2003-04, 74% had vacancies in mathematics, 56% in biology and the life sciences, and 51.5% in the physical sciences. Of the secondary schools with such vacancies, approximately 25% found it "very difficult" to staff these positions or were unable to fill the positions at all (Strizek et al., 2006).[3] In 2002, roughly 20% of public high school math and science teachers were either: 1) uncertified or partially certified in the math/science subjects they were teaching, or 2) fully certified in subjects other than the ones they were teaching—figures that have been increasing steadily since 1992 (National Science Board, 2006). Estimates suggest

[3] Vacancies in some other subjects were also high, but they proved much easier for schools to fill. For instance, of the secondary school with vacancies in 2003-04, 73% had vacancies in English/language arts and 65% had vacancies in Social studies. However, few of schools found it difficult to staff these positions (8% of schools struggled to fill the English vacancies and 3% the Social studies positions).

that about one-third of secondary math teachers and one-half of secondary science teachers have neither an undergraduate major nor a minor in a subject directly related to their field (Ingersoll, 2001).

Given the shortages of math and science teachers, and the questionable credentials of many of those currently teaching, proposals for improving math and science education often point towards the need to lure more qualified candidates to teaching. Frequently, professionals working in math- and science-related industries are cited as being a promising source of supply. In his American Competitiveness Initiative, for instance, President Bush referred to this potential cadre of teachers as an, "untapped resource… who have both content mastery and the practical experience to serve as effective teachers and positive role models for students who are interested in science or mathematics careers" (American Competitiveness Initiative, 2006).

There are at least three compelling reasons that math and science "mid-career entrants" might excel in public school teaching. First, and most frequently trumpeted, they may bring subject matter knowledge and technical skills to departments where many existing teachers are underqualified. Second, their experience working for demanding clients in competitive industries might mean that mid-career entrants would be undaunted by challenges—such as being held accountable for results (Costigan, 2002) or managing contentious parents (Johnson & Birkeland, 2003)—with which first-career teachers struggle. Third, schools might be better poised to tackle the complicated task of reforming math and science instruction if teachers were less isolated in their work. Mid-career entrants' experiences working in roles that involve interacting with clients and colleagues might infuse their departments, if not their schools, with the kinds of collaborative cultures that have helped private sector corporations operate more efficiently (Cohen & Bailey, 1997).

Although programs to recruit mid-career entrants are underway, there has been relatively little investigation of those math and science mid-career entrants currently entering teaching. Furthermore, most of the existing research on math and science mid-career entrants (e.g. Madfes, 1990; Merseth, Stein & Burack, 1994) was conducted in the mid-1990s, before many of the current efforts to recruit mid-career teachers were in place and before schools faced the accountability pressures that some new teachers find daunting. Thus, in an effort to learn more about the capabilities and experiences of math and science mid-career entrants, I conducted exploratory interviews with 10 such teachers who were working in four high schools in the greater Boston area. I sought to understand whether math and science mid-career entrants' former work had equipped them with the practical understanding of their subjects that policymakers had anticipated. To address this question, I asked participants whether they had: 1) worked closely with their subject matter in their former careers; and 2) developed subject-related skills from their prior work that proved useful in the classroom. Further, I inquired about whether participants brought additional skills from their former work that had eased their transition into teaching. Lastly, I asked participants to describe the nature of their interactions with colleagues in an effort to determine whether participants had opportunities to share their knowledge and skills.

I found that participants entered teaching with the kinds of knowledge and skills that might well help improve math and science instruction. In addition to possessing subject-matter knowledge, as well as the practical and technical skills required to apply this knowledge, participants brought additional skills—namely technological skills, communication and presentation skills, and grant writing capabilities—from their former careers, which appeared to provide them with a strong foundation on which to begin teaching. However, the organization of their schools and the isolated nature of teaching meant that participants had few opportunities to share their knowledge and skills with their colleagues and, in turn, to glean useful knowledge and skills from their experienced colleagues. Interestingly, participants were not dissatisfied by the limited level of interaction they found in teaching. On the contrary, many seemed to prefer their independent work as teachers to their interactive, but highly competitive, former careers. Faced with the discovery that teaching was, in the words of one participant, "a loner's operation," most participants worked within the constraints of their schools to maximize their informal interactions with colleagues. Several took more deliberate measures to secure meaningful opportunities to collaborate with their peers.

SAMPLE DESIGN, RESEARCH METHODOLOGY & LIMITATIONS

Sample Design

This exploratory study was conducted with a purposive sample of 10 math and science mid-career entrants who were teaching in the greater Boston area. To inform the selection of my sample, I conducted a preliminary analysis of the 2003-04 School and Staffing Survey (SASS) to determine, for instance, the types of schools where math and science mid-career entrants were likely to be teaching. From my SASS analysis, I discovered that the majority of math and science mid-career entrants (58%) choose to teach in high schools and in urban (53%) and suburban (20%) communities; thus, I selected 10 high school math and science teachers for this study, five of whom taught in urban communities and five in suburban communities. I sought participants who were teaching a variety of math- and science-related courses and who came from a range of math- and science-related industries. Further, I sought participants who were working in schools with different organizational structures (i.e. those organized into traditional subject departments as well as those organized into “small schools” or “academies”). To gather a range of perspectives, I sought to maximize the diversity of my sample in terms of age, gender and race; however, I was unsuccessful in locating non-White participants.

Because I wanted to interview participants at a time when the contrasts between their prior and current careers were clear, I sought participants who were relatively new to teaching but who had been teaching long enough to have formed impressions of their new career and worksite. On average, participants in my sample had been teaching for five years and had worked in their previous career for 16 years. The average age of participants in my sample was 48, substantially older, it should be noted, than the 33-year-old average age of math and science mid-career entrants yielded by my analysis of the 2003-04 SASS (see Table 1 on p. 7 for descriptive information about the sample).

Table 1: Demographic, Subject, and Career-related information on 10 study participants, grouped by school

Name	Age	Gender	Subject	Years Teaching	Years in Prior Career	District	School Organization	Prior Career Field
Joe	56	M	Math	3	30	Urban	Departments	Telecommunications
Kate	29	F	Math	3	2	Urban	Departments	Finance
Tim	47	M	Math	4	9	Urban	Small Schools	Statistical analysis / consulting
Jerry	52	M	Math	4	28	Urban	Small Schools	High-tech
Carter	51	M	Math/Science	5	19	Urban	Small Schools	Software programming / Management
Marcia	48	F	Math	10	14*	Suburban	Departments	Chemical engineering / Technical sales support
Roy	60	M	Math/Science	6	18	Suburban	Departments	Software programming / Management
Shelly	51	F	Science	8	14	Suburban	Departments/ Houses	Scientific laboratory research
Peg	57	F	Science	4	20	Suburban	Departments/ Houses	Electrical engineering
Kerry	30	F	Math	5	2	Suburban	Departments/ Houses	Management consulting

* Marcia spent 3 years working as a chemical engineer before her 14-year career in various technical sales support roles.

Research Methodology

Each mid-career entrant participated in one hour-long, semi-structured interview conducted in March or April, 2007. I asked participants why they had left their former professions, whether they had worked collaboratively with their colleagues in either career, and whether any skills and knowledge from their former careers had proven useful in teaching (see Appendices A and B for research questions and interview protocol respectively). All interviews were conducted in person, audiotaped and transcribed verbatim. I created thematic summaries shortly after conducting each interview, which allowed me to identify emergent themes and draft analytic memos. Upon receipt of the transcripts, I revised and expanded these themes based on my analyses of the transcripts. Using Atlas research software, I coded the transcripts based on the list of emergent themes. From the coded data, I refined my analytic memos and selected several prominent themes to address in this paper.

Limitations

Because this study is based on a small, purposive sample, my findings cannot be generalized to a larger population of math and science mid-career entrants. Rather, these findings are meant to identify and explore the skills and knowledge that this diverse sample of math and science mid-career entrants brought to teaching and their experiences interacting with colleagues in their current and former careers. Given the dearth of research on this subgroup of teachers, qualitative examination provides a necessary first step in building the kind of understanding of math and science mid-career entrants' experiences needed to design a larger study.

A further limitation of this work is that my interpretations are based solely on participants' self-reports about, for instance, the relevance of their skills and knowledge to their new careers. As such, my research design does not enable me to confirm or refute participants' claims about, for example, how effectively they had applied their skills and knowledge in the classroom. However, because I seek to understand math and science mid-career entrants' perspectives on their work and schools, self-reports are both appropriate and vital sources of data.

An additional limitation stems from my decision to create a sample of participants who had chosen to remain in teaching for several years. I determined that mid-career entrants would not be able to offer informed and revealing comparisons between their current and former work until they had taught for several years. However, by selecting participants who had remained in teaching for an average of five years, I likely selected a sample with a positive orientation to teaching. If I had included participants who had taught for one or two years, I might have captured the sentiments of mid-career entrants whose frustrations with teaching were prompting them to reconsider their career change. On a similar point, by selecting participants with extensive experience in their prior careers, I created a sample substantially older than the national pool of math and science mid-career entrants. I can imagine several ways in which the testimony of more senior participants might differ from that of their younger peers. These differences are not captured in this dataset.

Lastly, it is quite probable that the professionals working in math and science careers in the greater Boston area differ in important ways from those in other areas of the country. Outside of Silicon Valley, Boston is considered one of the centers of technological development and scientific research. My SASS analysis suggested that the 10 participants in this study were more highly educated and better compensated in their former careers than mid-career entrants nationally. Similarly, participants' former careers appeared to entail more demanding work than the careers of math and science mid-career entrants nationally. The lack of data in the SASS about survey respondents' former employers makes it impossible to compare the characteristics of these 10 participants' worksites with those in a national sample. However, given the competiveness of the Boston market, it is likely that the worksites of participants in this study were among the more innovative and demanding in the country. Readers should take these unique aspects of my sample and location into consideration when interpreting participants' sentiments regarding their former work and worksites.

THE PARTICIPANTS & THEIR FORMER CAREERS

The 10 participants in this study came from a range of math- and science-related industries and held a variety of roles throughout their prior careers. Before becoming teachers, Roy and Carter, had worked in computing as programmers, team-leaders, and mid-level managers. Both Peg and Jerry had been design and applications engineers in the high-tech industry; in addition, Peg had worked as an electrical engineer and Jerry as a software engineer. Peg and Jerry had also been entry-level "contributors" as well as managers. Joe and Marcia had spent the majority of their careers working in telecommunications, Joe as a civil engineer and Marcia in technical sales and support. In their prior careers, Shelly had been a researcher at a university-affiliated molecular biology lab, Kate had worked in financial budgeting and forecasting at a large consumer electronics company, and Tim and Kerry had both worked as consultants—Tim at an antitrust and litigation consulting firm and Kerry at a management consulting firm. Most participants whose initial career had spanned more than five years had worked for a number of different companies, some notable exceptions being: Joe, who worked for the same telecommunications company for 30 years; Shelly, who conducted research at the same laboratory for 14 years; and Tim, who worked as a statistical analyst for the same consulting firm for nine years.

The characteristics of participants' former worksites varied, though most had spent a portion of their careers working for large national or multi-national companies that employed hundreds or thousands—in some cases, tens of thousands—of workers. About half of the participants had worked in companies that differed in terms of size and history. For example, Roy and Carter had worked at small "start-ups" as well as long-established industry giants. Shelly was the only participant who had spent the entirety of her previous career in a relatively small organization; her lab employed about 20 workers, including post-doctoral fellows and technicians.

About half of the sample—including Joe, Kate, Tim, Peg, and to a lesser extent, Marcia—had liked their former work and worksites and had been generally satisfied in their prior careers.[4] Many of the participants within this half of the sample reported finding their work both intellectually challenging and enjoyable. For most of these participants, the decision to change careers was motivated by an interest in either: 1) wanting to try a different line of work; 2) finding a job that afforded them more time with their families; or 3) performing work that was more likely to "make a difference" or result in some tangible improvement in the lives of the people with whom they interacted.

[4] Marcia had not enjoyed all of her roles or worksites, but had liked the software sales and support job that she held for the six years preceding her career change.

The other half of the sample—including Kerry, Shelly, Carter, Jerry, and Roy—had liked some aspects of their former work and worksites but had grown weary, in some cases disgruntled, with others. Many of these participants cited the following qualms with their former work, worksites, or industry: 1) their work, though often challenging and exciting, had been exhaustingly stressful; 2) the cultures of their worksites had been intensely competitive or oppressively hierarchical; or 3) their industry had changed in a way that lessened their interest in their work. While many of these participants had also been seeking more meaningful work and more time with their families, their decision to leave their former career was strongly influenced by their dissatisfaction with their work, worksite, or industry.

A number of additional factors influenced participants' decision to leave their former careers and enter teaching. Joe and Kerry discovered that they liked teaching while participating in programs that brought workers from their former employers into classrooms to teach mini-lessons. Peg, Marcia and Kate discovered their aptitude for teaching while instructing coworkers or clients, or working with student peers during their academic training. Several participants had siblings or friends who were teachers and who spoke enthusiastically of the profession. Others, like Carter, had considered teaching at the outset of their careers but had not entered the field due to long-term financial concerns or immediate financial constraints (e.g. student loans). Tim's decision to teach had been influenced by the role one important high school teacher had played in cultivating his interest in math; other participants—like Marcia, who had graduated first in a high school class of about 400—had been told by former teachers that their talents would be "wasted" in teaching. Two participants had been laid-off during their prior career, an experience that had prompted one to worry about decreasing job security and increasing age discrimination in his industry.

To make sure they liked teaching, three participants had tried substitute teaching or tutoring before securing full-time teaching positions. Once participants had decided to become teachers, five had pursued alternative certification routes, such as the Massachusetts Department of Education’s “panel review” or the Massachusetts Initiative for New Teachers program (MINT).[5] Four participants had entered traditional university Masters of Arts in Teaching certification programs. One participant had chosen to pursue an Ed. M. and was in the process of fulfilling additional state requirements to obtain her teaching license.

FINDINGS

Overview

Four major findings from this study are addressed in this section of the paper. First, I describe the knowledge and skills that participants reported bringing from their former careers and from their undergraduate and graduate training. I describe both the subject-related and the non-subject-related knowledge and skills that participants found valuable in their work as teachers. Second, I explain how the organization of participants’ schools and the isolated nature of teaching limited participants’ ability to: 1) share their knowledge and skills with colleagues, and 2) solicit guidance from their experienced peers. Third, I explore how the realities of participants’ new careers affected their

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[5] MINT is a state-sponsored, accelerated certification program designed to recruit working professionals into math, science and English teaching positions in high-need school districts. For additional information, see: https://www.doemass.org/mint/

satisfaction in teaching. Finally, I describe how participants responded to the organizational circumstances they encountered.

<u>FINDING #1</u>: Participants brought valuable knowledge and skills to teaching

One of the most common arguments for recruiting math and science mid-career entrants to teaching posits that their professional experience will equip them with a practical understanding of their subject discipline that is superior to the limited book knowledge possessed by their first-career counterparts. More than one-half of the participants reported bringing practical, subject-related knowledge and skills from their former careers that informed their work as teachers. Many also indicated that their undergraduate and graduate studies were critical in preparing them with the subject-related knowledge needed to teach. Further, participants reported that they brought additional skills from their former careers—namely technological skills, communication and presentation skills, and grant writing capabilities—which were also useful to their work as teachers. It appeared that the benefits associated with participants' knowledge and skills accrued primarily to the participants themselves and to the students in their classrooms. Participants also reported that their students' parents and their colleagues benefited from the knowledge and skills that participants brought from their former careers.

Subject-related knowledge & skills

Nearly all participants reported bringing extensive subject-related knowledge and skills to teaching. The depth of these capabilities seemed related to two factors: 1) the extent to which participants' former jobs involved working with the subjects they were now teaching, and 2) the undergraduate and graduate degrees participants had obtained in their subject areas. One-half of the sample reported having worked extensively with their subject in their former career. For these participants, strong subject-related knowledge and skills were required to perform organizational tasks. For example, Tim's primary responsibility as a consultant was fitting complex statistical models. Peg's first career as an electrical engineer involved "math all the time," as well as intimate knowledge of physics and chemistry. Similarly, Shelly relied on much of the same scientific knowledge—and performed many of the same techniques—in her former work as a molecular biology researcher and in her current work as a science teacher. Several participants' work appeared to entail slightly less subject-related work. For example, as a sales support engineer, Marcia had to be familiar with probability in order to create the "discrete event simulators" that helped her clients predict "bottlenecks in their production lines." However, Marcia reported that, "other than [basic probability], not a whole lot of math" was required by the job. At Joe's former telecommunications company, "heavy math" was handled by statisticians and analysts in other departments, while Joe performed "business-oriented math," such as accounting. Several other participants reported that their work required little or no subject-related knowledge or skills at all. For instance, Kerry's work as a management consultant involved "no math." Although Roy reported that software programming can require substantial mathematical knowledge, the projects he worked on did not.

Despite this variation, all but one of the participants reported feeling well prepared to teach their subjects at the outset of their new careers. Participants indicated that their confidence was strongly influenced by their academic training in their field. All participants had received either an undergraduate and/or graduate degree in a field related to the subjects they were teaching. For example, Roy—now a math teacher—held a bachelor's degree in mathematics and a Ph. D. in computer science. Carter, also a math teacher, had both undergraduate and graduate degrees in physics. Similarly, Shelly held undergraduate and graduate degrees in biology. Kate, a math teacher, had been a finance major in her undergraduate business administration program prior to entering her first career in finance.

Several participants whose former careers had *not* involved working extensively with their subject reported developing analytical skills that were relevant to their work as teachers. For example, Joe, who had performed mainly lightweight "business oriented" math as a telecommunications engineer, reported developing analytical skills from having to perform "reasonability checks" on data that were given to him by his organization's statisticians. Joe learned how to break complex problems into "discrete steps" and to develop processes that allowed him to catch "problems and inconsistencies" in his team's work. By introducing students to these analytical approaches, Joe thought he could teach students how to "solve any problem." Similarly, Roy discovered that his work as a software programmer involved many of the same analytical processes as the sophisticated math he'd studied in his degree programs. Roy explained, "[As a programmer], I didn't ever implement anything that had to do with a vessel function or a linear algebra theorem, but I was thinking mathematically all the time." He elaborated:

> Everything I did was logic, everything I did was case analysis. Can I prove that this is what happens here? In my head, I'm thinking about the same thing you're doing when you're doing a trig[onometry] identity. I'm taking some program and thinking, "this seems to be a lot of code to do what I need to do. How can I achieve the same goal more efficiently and with less code?" And that's the same thing you do when you're reducing a complex expression to a simpler expression.

Roy found that the analytic skills he developed as a programmer were as valuable to share with his students as the mathematical knowledge he'd gained from his academic training.

Participants described numerous benefits associated with the subject-related knowledge and skills that they brought to teaching. For one, their subject-related strengths meant that preparing to teach involved reviewing material rather than learning it for the first time. "Oh, I was brushing up over the summer before I started," Joe remarked casually, suggesting he was undaunted by any subject-related concerns leading up to his career change. Shelly, who had worked extensively with her subject as a lab researcher, acknowledged that there were "details" related to her teaching assignments that she, "did not know and had to learn in order to teach." However, Shelly explained that the "depth and breadth of [her] understanding [of biology]," enabled her to explain the technicalities of lab research with relative ease. She explained:

> I know what I'm talking about when I come into the classroom… I really know how molecular biology is done, how cloning is done, how proteins are analyzed... So there's a real grasp of the material that is second nature up to a point where I just don't have to think about it. And if kids throw me a question, I'm comfortable enough that I can come at it from a million different directions until I'm able to explain things in a way they'll understand. And I'm not sure that I would have that, particularly about something as abstract as molecular biology, if I hadn't been immersed in it for so long.

Nearly all participants reported that their familiarity with their subjects allowed them to generate practical classroom exercises. For example, Jerry introduced students to the coordinates system by describing how it was used in the flight simulators manufactured by one of his previous high-tech employers. Roy's experience as a software programmer allowed him to explain to his students how a "phenomenal amount" of trigonometry had been used to create the realistic images in their computer games. Peg introduced concepts to students by first thinking of an example from her work as an electrical engineer that illustrated the concept. She described her process:

> I say, “Well, when we were designing power supplies for the first cell phones…” or, “Did you ever think about what’s going on inside your [cell phone] display?” or, “What do you think about airbags? Now when we were designing the circuitry for airbags…”

Carter relied on the mathematical knowledge he had developed as a software programmer and manager, and as an undergraduate and graduate physics major, to generate exercises that he believed were superior to those available in the texts at his large, urban high school. He reported encountering “real-world” examples in his school’s textbooks that were neither rigorous nor accurate portrayals of how mathematics is used in industry:

> I really wish that math textbooks weren’t written by people in education. I wish they brought in people from business or people from science or something, because the examples they come up with and the problems they come up with are ridiculous sometimes. Practically every day I’m thinking of giving this or that problem and I look at it, and I just have to laugh because it’s a “real world” application and I’m going, “What is the real world that you live in?” because that’s nothing like what is out there.

Like other participants, Carter found that he was able to create exercises based on scenarios he faced in his prior work that were both more rigorous and realistic than those available in texts.

In addition to garnering, in Peg’s words, “credibility and cachet” with students, participants’ real world examples introduced students to the tasks and standards of various math and science-related careers. Jerry reported that the students in his large, urban high school had, “no idea what high-tech [was] about.” Thus, developing exercises based on his experience gave students a better sense of the kinds of problems that engineers in this field encountered. Similarly, by explaining to students how a “particular

[math] skill played a role in computing," Roy was able to reply to students when they asked, "When are we going to need this in our real lives?" Roy would respond, "Well, I certainly would not have hired someone to work for me who couldn't prove a geometric identity" and then illustrate how geometry and programming were interrelated. "So I'm able to sort of give some reality to the importance of the skills," Roy explained, "because those are the skills that make people good engineers." Marcia found that students who were interested in careers in engineering and the "hard sciences" often undervalued the importance of statistics. On these occasions, Marcia informed students, "I took three statistics classes as an engineering student, so don't think that that's not useful to you, because it is." Shelly felt that her experience working in the lab allowed her to teach students professional standards regarding reporting lab results—knowledge that would serve them well if they chose to pursue future scientific work or study.

Additional knowledge & skills

In addition to their subject-related knowledge and skills, participants also brought a familiarity with technology, grant-writing abilities, and communication and presentation skills that further supported their work as teachers and brought valuable resources to their schools. While participants' subject-related knowledge and skills appeared to benefit their own teaching, these additional capabilities seemed to have benefits that extended beyond the classroom.

Technological knowledge & skills: Nearly all participants reported bringing a familiarity with technology from their former careers. Their reliance on technology in their prior work made it easy for them to use hardware and software to both organize and execute their work as teachers. For example, as a telecommunications engineer, Joe's “whole career was involved with [technology].” He used spreadsheet applications to keep track of the logistics of numerous state and national projects. As a teacher, despite school administrators issuing “more and more requirements” to utilize organizational software, Joe saw many of his less tech-savvy colleagues resist these mandates. By contrast, Joe’s “having to deal with lots of changes in technology and different ways of operating over the years” enabled him to “jump right on” and begin using educational technology immediately. Before long, Joe discovered how he could use software programs to link student data (e.g. grades, days absent, etc.) to progress reports. Joe created records that allowed him to inform a student, parent, administrator or colleague of a student’s progress. “It’s all here,” he said, scrolling through spreadsheets on his computer, “…all my grades, days absent, 2005-2006 materials, progress reports, new tests… if I want to look at a summary and see how the kids are doing overall, I can look at this stuff… If a student asks me, ‘What do I need to get a B?’ I can just plug a number in.” If a parent ever challenged Joe’s assertions about her child’s performance, Joe could instantaneously present records of the student’s work, electronic copies of progress reports that were e-mailed to the parent, and threads of e-mail correspondence that had occurred between Joe and the parent. He found that the content and organization of his records quickly quelled any disputes.

Beyond aiding in the organization of his work, Joe also found that technology enhanced his instruction and helped hold the interest of his students. He used programs like Geometry Sketchpad to display and manipulate mathematical objects in order to answer questions that arose in the course of a presentation. The slides he created before and during such presentations were archived so that interested students could review the material at a later date. Numerous participants reported developing similar technological skills in their prior work and using these skills to help organize and execute their work as teachers. For example, as a sales support engineer, Marcia's primary responsibility was to demonstrate to prospective customers how her company's software could be used to streamline their production lines. To execute this task, Marcia became a self professed "techie," intimately familiar with both her company's software and with the hardware her clients used in conjunction with her product. When Marcia became a teacher, she found that her familiarity with technology made her "an early adopter" of useful educational software and hardware. Illustrating her point, Marcia reported, "I gravitated quickly to the graphing calculators. I can do pretty much anything with one of those." Despite finding these calculators a powerful tool, Marcia said she was one of only three people in her seventeen-member math department who had become "really good with [them]."[6] As a statistical consultant, Tim built mathematical models that helped clients determine, for example, how much of a product they would sell if it were offered at different prices. From this work, Tim developed technological skills that supported his efforts as a teacher. He explained:

> I certainly learned a lot about databases and programming and spreadsheets, which made it easy to do a lot of things to make stuff for my students and to prepare worksheets and geometry stuff. I was familiar with all of that, so it was easy to format things and learn how to use [educational software] to make my own materials, so that I didn't have to rely on what I could find in a book or steal off the internet. Those skills were definitely useful.

Participants found that their technological capabilities were highly sought by their less tech-savvy colleagues. Marcia discovered the value of her technological skills while

[6] One of the other two teachers adept at using graphing calculators was Roy, a mid-career entrant and participant in this study. The other was an experienced first-career teacher.

student teaching. She was paired with a veteran mentor who was, “very old school in terms of his use of technology.” Marcia’s mentor offered to share his wisdom about “how to manage a classroom of rowdy kids” in exchange for Marcia’s tutelage in mathematical software. In her current position, Marcia’s interest in and aptitude for technology prompted her to collaborate with colleagues in different departments to create professional development programs. Other participants also reported that their technological skills had benefits that transcended the confines of their classrooms. For example, Roy reported that his technological capabilities allowed him to offer valuable instruction to his colleagues. “Because I’ve built so many programs,” he explained, “I certainly feel comfortable teaching computing to people. And I do tend to do that on occasion. For example, I taught one of my colleagues how to program Java so he could do a research project.”

Communication & presentation skills: Participants also reported that they had become clear communicators and adept presenters from working in careers that involved interacting with colleagues, superiors and clients. Having grown accustomed to making both formal and informal presentations to a variety of audiences, participants had little trouble feeling confident while leading a class, being observed by an administrator, or dealing with contentious parents. As many of the quotes in this section illustrate, participants not only brought with them skills as presenters and communicators, they brought the confidence associated with having applied these skills in competitive, demanding settings. Participants appeared to be well served by the skills themselves, as well as by the confidence to practice these skills in their new worksites.

Nearly all participants reported that, in their former work, accomplishing organizational objectives well required extensive interaction between individuals within and outside their organizations. For example, Jerry could not have executed his responsibilities as a systems engineer without interacting with coworkers in other departments within his organization. His department received software that had been created within another department, “bundled” the software so that it could be installed on a client’s system, and then transferred the bundle to another department, which would then simulate the installation before sending the product back to Jerry’s department to resolve any “bugs” that had emerged. Frequent interactions and presentations, both formal and informal, were required throughout this process to insure that critical information was passed from one department to the other. Carter, a former mid-level manager in the software industry, explained how his work involved interactions in three general directions within his organization: 1) interacting “left and right,” or with managers in other departments to synchronize the timing of their work and to insure that departmental objectives were aligned with organizational goals; 2) interacting “downward,” to explain work tasks to the developers that worked within his department; and 3) interacting “upward,” with senior administrators to inform them of his department’s progress. While most of Carter’s “downward” interactions were informal, the “upward” progress reports to senior managers often entailed formal presentations. Perhaps Carter illustrated the importance of interaction between colleagues in the software industry best when he remarked, “My God, if people couldn’t work together, these businesses would have fallen apart.”

In addition to making presentations to colleagues and superiors within their organizations, some participants were required to interact with, and make presentations to, audiences outside of their organizations. For example, Marcia's work as a sales support engineer involved presenting her company's software to prospective clients. Senior managers at Kerry's management consulting firm would often make impromptu demands in front of clients that she present overviews of her team's work. The culmination of much of Joe's work as a telecommunications engineer was the testimony he presented at formal state and federal hearings.

Participants reported that their interactive former careers had made them clear communicators and adept presenters—skills that they claimed enabled them to feel confident at the head of the classroom and in their interactions with their students, students' parents, and administrators. For example, Kerry's practice making impromptu presentations in front of clients had left her confident in her "ability to think on [her] feet." As a result, she did not feel like "a stuttering nightmare" in her first year of teaching. "I just didn't feel overwhelmed," she recalled, "I felt more confident. I had already done all that." Similarly, after nearly three decades of making presentations at "public meetings or to big groups at work," Joe remarked, "I feel pretty comfortable in front of a group. I'm not going to be nervous up there [at the head of the classroom]." Further, Joe felt comfortable in his interactions with administrators and parents. He explained, "I just don't feel nervous about anything I have to do. Dealing with the administration or with some of the parents I've had to deal with, I've thought, 'Oh man, if I were brand new at this, this could be pretty unnerving.' But it's just not going to have an effect [on me]. I'm not trying to toot my own horn, but having the kind of experience that I've had makes [these responsibilities] much easier." Like Kerry and Joe, Peg also felt that the practice making presentations to diverse audiences, and the precision this communication required, served her well in teaching. From her work as an electrical engineer, Peg had learned the value of "being clear in your communications and expectations." She relied on these skills in her interactions with students. "Kids hate it when you screw around with them," she explained, "I'm very clear. Homework's on the board. If it's late, I don't care if it's late a day, two weeks, end of the term, it's 15% off… this is what I expect and this is what will happen. If you keep it clear and simple, they respect that."

Many participants, like Joe, reported that their experience interacting with different audiences prepared them for interacting with their students' parents. For example, Marcia's experience presenting her company's software to prospective clients who were senior executives taught her how to interact with the high-powered parents in her suburban school district. She noted:

> I think I've had less trouble dealing with parents than I would have if I hadn't spent 10 years in sales. Being a salesperson taught me a lot about how to deal with people. I can schmooze people. I learned how to talk to people at different levels of an organization, and that's been very useful. So if somebody comes in here and they're vice president of a Fortune 500 company, I'm not particularly intimidated. I'm not a pushover and that's pretty clear, so [the parents] don't typically mess with me. I think that comes from being a mid-career entrant. Having that confidence in myself as I came in [to teaching] was a huge asset.

Similarly, the communication skills that Roy had honed as a programming manager left him undaunted by the challenges of interacting with this same group of parents. He explained:

> I think there's some ways in which I'm able to use the weight of age and experience and my ability to present myself in class [to inform my interactions with parents]. When they come in on back-to-school nights, they don't get any

> impression from me other than a guy who knows math, knows the class, knows the school, has done this before. Because I’ve managed all kinds of audiences, I know how to give the humorous response to a [parent’s] question that both answers the question and puts me back in command.

Participants, like Roy and Marcia, who worked in suburban communities seemed more likely to encounter parents who challenged their authority and competence than participants who worked in urban settings. However, participants working in urban communities also found that their communication and presentation skills informed their interactions with parents. Both Jerry and Joe, who worked in different urban schools, reported that their experience working with employees at all different levels within their organizations allowed them to communicate with parents from a variety of backgrounds in order to help students who were struggling academically.

Grant-writing skills: Two participants, Peg and Joe, reported that their familiarity with securing external grants in their former careers was valuable in their new work as teachers. For instance, as a teacher, Joe received a grant to equip several classrooms with LCD projectors, which were used to display presentations that teachers created with software like Geometry Sketchpad. He was in the process of applying for another grant that would equip five classrooms with tablet computers and wireless routers that would further aid such presentations. Joe believed that his technological savvy was a capability that distinguished him from his colleagues. “Everyone’s giving away lots of money,” he acknowledged, “You just have to know where it is… as far as other teachers getting grants, at least in the math department, I don’t know if anyone [else] has.”

<u>FINDING #2</u>: Participants had limited opportunities to share knowledge & skills

Despite bringing valuable knowledge and skills to teaching, participants reported having few opportunities to share what they knew with their colleagues. While nearly all participants reported that their knowledge and skills informed their teaching and their interactions with students and students' parents, they described relatively few examples of how their capabilities affected their colleagues. Unlike their former careers, in which there was much interaction, as teachers they performed the central task of their work, classroom instruction, independently. While there were occasional opportunities for participants to interact with colleagues before and after instruction took place, these interactions were typically brief and informal—rarely systematic opportunities for participants and their colleagues to share their respective strengths in depth. Further, the organization of participants' schools, and the limited technological infrastructures within them, reinforced the teachers' isolation. Taken together, the isolated nature of teaching and the cellular organization of participants' schools meant that participants had scarce opportunities to share the knowledge and skills that they brought from their former careers. There were equally few opportunities for participants to glean useful knowledge from their experienced colleagues.

The isolated nature of teaching

As documented, in participants' former careers, they were required to integrate their work with work produced by colleagues and to make presentations to superiors and clients. These organizational demands brought them into frequent contact with individuals within and outside of their organizations. In teaching, by contrast, participants reported having limited contact with anyone other than the students in their classrooms, corroborating previous findings about the isolated nature of teaching (e.g. McLaughlin and Talbert, 2001; Johnson, 1990; Goodlad, 1984; Lortie, 1975). Nearly all participants described having far fewer interactions with colleagues in teaching than they had had with their coworkers in their former workplace.[7] Tim spoke for many participants when he reported, "There's very little, if any, collaboration here. There was a lot more collaboration in industry than there is here. I was more a part of a team at [my consulting firm]. Here, it's kind of like you've got 180 people all doing their own thing." Kate echoed Tim's sentiments when she remarked, "I had a lot of interaction [in my former job in finance]. I came here and I was very isolated in my classroom." She noted, "You are in your classroom so much because you're either with the kids or you're correcting and planning for the next time you're with the kids." Roy explained that there were no organizational tasks in teaching that intertwined colleagues' work:

> Teaching is much more of a loner's operation, even in this place where there's a lot of collaboration… it's still you in front of that class. It's still you grading that pile of tests. It's still you making [the tests] up. It's still you deciding what to do about the fact that your kids didn't do very well on that exam. It's still you dealing with the cheating in your classroom. There's not a real opportunity for collaboration in the way that we collaborate in industry.

That Roy found teaching more of a "loner's operation" than software programming is notable for several reasons. For one, Roy's description of his responsibilities as a programmer suggested that his work involved *more* independent tasks than the jobs of many in the sample.[8] Second, as his quote illustrates, Roy believed that his school and

[7] Shelly, the former lab researcher, was the only participant whose previous career seemed to involve a similar level of interdependence and independence as teaching. Marcia's career in technical sales support hadn't involved interacting with many colleagues, but the frequent contact she had with clients made the work feel interactive. All other participants portrayed their former work as notably more interactive than their work as teachers.

[8] In this sample, Joe, Tim, Kate, Jerry, and Peg all described having responsibilities that entailed more interaction than Roy's work as a programmer.

department were relatively interactive. Indeed, of the schools represented in this study, Roy’s school (based on the testimony of Roy and Marcia) did appear to have the greatest amount of interaction among teachers. Thus, if Roy found teaching isolating, it seems likely that math and science mid-career entrants whose former work involved a great deal of interaction, or who are working in relatively non-collaborative schools, might feel more strongly in this regard.

In teaching, because organizational tasks and outcomes did not require colleagues to collaborate, most interactions were brief, informal, and optional. Joe illustrated this point when he stated simply, “There’s a lot less of the need for day-to-day interaction. If [a teacher] doesn’t want to interact much, he could do that.” Most of the interactions that participants described were impromptu and occurred in between class periods or during lunch. As Shelly explained:

> I would say the vast majority of [the interaction in teaching] occurs on-the-fly. We do have discipline meetings once a week, meaning the biology teachers allegedly will all work together; however, our schedules don’t mesh. We try to build in structured meeting time, [but] it’s really difficult. Really, really, difficult. So, I think the best [collaborative] stuff gets done on an ad-hoc basis, often under desperate circumstances.

Like Shelly, most participants reported that the majority of their interaction with peers occurred during lunch. Occasionally, these interactions addressed subject-related topics and sparked stimulating conversations between departmental colleagues. More often, they were opportunities to chat informally, share resources (such as a review sheet or quiz), or exchange last-minute tips on how to introduce a topic. While participants valued these interactions, they did not appear to be substantive enough to change participants’ general sentiment that teaching was isolating work. Further, given their brevity and unpredictability, these informal interactions rarely seemed to be opportunities for participants to share the knowledge, skills, and resources they brought from their former careers.

The kinds of interactions that might have allowed participants and their colleagues to share their respective strengths, such as team-teaching or observing and debriefing classes, were not common in their schools. On the topic of team-teaching, Shelly lamented, “Oh, we dream of teaching together. But, no, the scheduling hasn’t allowed it to happen yet.” Similarly, while Kerry reported that she would “love to team-teach,” she did not see any way that it was possible. “We teach the same way (in isolation) we’ve done it for 100 years,” she bemoaned, “not so innovative.” Kerry also desired more feedback on her work than the isolated nature of teaching afforded. “I would love to be observed more frequently,” Kerry reported, “No one sees what I do. How do I get better if no one observes me? It’s weird not to have anyone observing your work. In what other jobs does no one see what you do?”

Formal opportunities to interact with colleagues, such as during department meetings, afforded equally few opportunities for participants and their colleagues to share their knowledge and skills. Formal faculty meetings were infrequent and brief and were usually spent addressing pressing departmental issues, such as developing common assessments or deciding which texts to use. Kate said that department meetings were usually opportunities to, “make finals, mid-terms, develop curriculum guidelines [to accompany new texts], plan the department math fair… things like that.” Tim, whose school was divided into small-school units rather than subject-specific departments, reported that, on the rare occasions that subject teachers were able to meet, their meetings were governed by objectives similar to those which Kate described:

> Once a month, we have these half-day professional development meetings. Sometimes we get half the half-day. It's pretty much been used to do things like work on updating the common midterm and final and curriculum guide. So, not any real professional development in mathematics… We have very little time to work together on curriculum, develop lessons or improve [our] teaching of mathematics.

Given the infrequency of formal meetings and the need to address pressing issues during them, opportunities to discuss instruction were rare. Jerry, one of Tim's math colleagues, explained:

> We have begged, borrowed and stolen time during the course of the year to get together with other teachers who are working on the same subject before big exams and say, "We're at this point here, you need to be at this point before the final exam or the midterm exam." We *might* (Jerry's emphasis) get to talk about certain things that we're doing in the classroom, but those times are very, very few and far between. I'd like to see them happen more often.

As these quotes illustrate, formal meetings were rarely opportunities for participants to discuss their subjects, or how to teach them effectively, with their colleagues. Thus, they appeared to hold little promise as opportunities for participants to share the knowledge and resources they brought from their former careers. Had there been more time in these formal meetings, and had the meetings been focused on matters pertaining to teaching and learning, Jerry and his colleagues might have been able to discuss the benefits of using practical classroom exercises rather than those in available in their texts. During such a conversation, Jerry might have shared the coordinates system exercise he'd developed to spark the debate. Similarly, Marcia might have presented a compelling case for using the graphing calculator in conjunction with certain lessons. No participants described having such opportunities during formal meetings.

Just as participants brought valuable knowledge, skills, and resources to teaching, their colleagues possessed a wealth of instructional experience that might have informed these participants' efforts in the classroom. Participants were unanimous in their portrayals of colleagues as being knowledgeable of their craft and generous in sharing materials and resources. However, the isolated nature of teaching meant that participants had few opportunities to glean in-depth information on the finer points of teaching from their experienced colleagues. Speaking generally, Carter illustrated this point when he remarked:

> Each [new] teacher is starting from scratch and, on the basis of your own experience, you have to come up with things to try. And you're not going to get a lot of help. You're in your own little room and you are locked in there with the students.

Kate also found that the isolated nature of teaching made it difficult to solicit advice from her math-teacher colleagues. In her third year of teaching Kate finally had a common planning time with a colleague who was teaching the same subject. They used this time, which had occurred in the schedule out of pure luck, to develop lessons to accompany a new text. Kate believed the experience had been beneficial for both teachers, but she expressed dismay that such opportunities were left to chance rather than structured into the schedule: "There's no common planning time. It's chance of luck if you happen to have the same period off that someone else does." Jerry had also benefited from a similar stroke of luck, but he still found it difficult to get practical guidance from his seasoned colleagues. In his first year of teaching, Jerry happened to be assigned to the same small school as a veteran math teacher who'd previously taught many of Jerry's classes and students. While they did not share a common planning time, Jerry was able to gain valuable insights from this colleague during brief exchanges before the school day began. Jerry recalled longing for more established occasions to seek guidance and discuss instruction in his first years on the job.

The organization of participants' schools

Participants reported that the organization of their schools reinforced the isolation in which they worked. Regardless of whether they worked in schools that were divided into traditional departments or smaller schools, nearly all reported that the organization of their schools inhibited interaction. In addition, participants reported that their schools' physical layouts and limited technological infrastructures made it difficult to have more than the brief, informal interactions described earlier.

Organizational structures: Three of the schools in this study were organized by traditional, subject-area departments. One was further subdivided into grade-level houses. The fourth school in the sample was divided into small-school units that were comprised of teachers from all subject disciplines. None of these organizational structures seemed to promote meaningful interactions among teachers. The small-school organizational structure allowed teachers to monitor student progress and exchange ideas about, in Tim's words, "basic pedagogical things like classroom management." However, it did not provide opportunities for participants to engage in the kinds of subject-related discussions that might have showcased, for example, their practical understanding of their subjects. Jerry concurred with Tim, reporting that his school's small-school structure afforded only minimal opportunities to work on subject-related tasks:

> I think [the small-school structure] inhibits [the kind of interaction I'd like to have with my math-teacher colleagues]… it's good to have the cross curriculum thing where you're meeting with history and English and science teachers, but I'd like to have more opportunities to meet with math teachers. I'd like to be in a position where I could get together with more of my algebra or my geometry colleagues and talk about…you know, "What are you working on? How did you do that lab in class? How did you do that? How did you introduce this topic?" I think that would work out really well. In a lot of ways I feel like I'm working in a void. I think that that working with people that are teaching the same subject would help.

The math coordinator at Jerry's school had deemed the isolation among math teachers so limiting that he succeeded in getting an external grant to compensate math teachers for participating in professional development outside of the school day. About one-third of the department attended these meetings, including the three teachers from this school who participated in this study: Jerry, Tim, and Carter. Had it not been for this grant, Tim doubted that he would know the names of half his math department colleagues—this after four years of full-time employment. These three participants were able to share their subject-related expertise with colleagues during these sessions; however, they wished it were possible to have similar interactions during the school day. Further, given that an external grant was required to ensure departmental interaction, it seems likely that mid-career entrants' subject-related capabilities will remain untapped at many schools that are similarly organized.

Jerry, Tim, and Carter all imagined that a departmental organization would be more conducive for discussing instruction and subject-related topics. Interestingly, participants who were organized into traditional departments also described having few opportunities to engage in such discussions. Participants who were organized into departments *did* appear to have more informal contact with colleagues teaching the same subject. However, the nature and brevity of these interactions meant that they were primarily opportunities to exchange pleasantries or engage in light banter about subject-related topics. Similarly, while participants in traditionally organized schools were not forced to meet with departmental colleagues outside of the school day, formal departmental meetings were still devoted to taking care of basic requirements, such as developing common assessments. The grade-level houses that complemented the departments at Shelly and Kerry's school did little to promote interactions among teachers. Shelly described the purpose of the houses:

> [The house structure] is to distribute paperwork… there's not a whole lot of collaboration that goes on. Because all of our home rooms are a particular grade level, we meet a couple times a year to discuss the junior semiformal and what the rules are or how to facilitate certain things. When the kids are seniors, we meet a couple times to talk about graduation, so [the houses are] administrative more than anything else.

Thus, none of the organizational structures represented in this sample seemed particularly effective at tapping the knowledge, skills, and resources participants brought from their former careers.

Physical layouts: The physical layouts of participants' schools also limited the extent to which participants and their colleagues were able to exchange their respective strengths. Few schools had common rooms where members of the same organizational unit (i.e. department or small-school) could meet, meaning that many participants remained in their "egg-crate" classrooms for much of the day (Lortie, 1975). In Kate's case, the classroom she was assigned in her first year of teaching was at the opposite end of the building from where the math department classrooms were located. Kate's physical location made it virtually impossible to exchange ideas and resources with departmental colleagues during the short periods between classes. It wasn't until her room was relocated that Kate even had the opportunity to meet many of the teachers within her department. In Kate's former workplace, by contrast, cubicle suites enabled a relatively effortless flow of information between team members and across departments. Kate compared the benefits of her former and current worksites' layouts when she remarked, "It was very easy [in my former worksite] to just poke your head over and grab something from someone else… I came in as a new teacher and I was placed in the top floor in the corner in the foreign language department. So, a little eye opening. I really didn't have any math teachers to fall to."

Roy and Marcia's school, which was organized into subject departments, appeared to have the physical layout most conducive for promoting interaction among teachers. About three-fourths of the math teachers had desks in one of two departmental offices where they could work during free periods or before or after school; the remaining department members worked in their own classrooms. While Roy, whose desk was in the larger of the two offices, saw benefits to this physical arrangement, they did not outweigh his general sense of isolation. Roy explained:

> This [physical arrangement] is done on purpose to try and provide more chance for us to be able to talk. And in fact, we do. We can just turn around and ask somebody a question: "What do you think about this?" or "I haven't done this before. Could you help me? How do you teach this?" There's a lot of that kind of stuff going on. Whereas, if we each had our individual rooms, it'd be much harder to get that to happen. So this is a department where the ethos of the department is collaboration and sharing and helping each other, and it's organized to do that, and people, in fact, carry that out. And yet it still feels to me like a loner's job.

The physical structure of Roy's school may not have changed his sentiments about the isolated nature of teachers' work; however, he was one of the few participants to describe engaging in the kinds of interactions that might allow him and his colleagues to share their respective knowledge and skills. When asked to describe the interactions that take place in the department office, Roy described one occasion where a coworker (a first-career teacher) introduced Roy and his colleagues to fractal demonstrations that he'd discovered on-line. Roy also described the following scenario:

> One of the students in an honors class [might] ask, "But what if you, da, da, da, da?" And the teacher thinks about it and says, "I don't know. I'll get back to you on that." And he goes back to his desk and thinks about it for a while and realizes that he doesn't know the answer. So he says [to his departmental colleagues], "Have you ever thought about this? What happens if you take a parabola and cant

> it some amount to the right? Does it always cross the Y axis?" And so three or four of us end up sitting around the table going, "Well, let me think…" Maybe later in the day we've figured it out or we haven't and we're looking up stuff in books, but we're interacting about math.

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Roy's examples suggest that a school's physical layout may play an important role—perhaps an equally or more important role than a school's overarching organizational structure (i.e. departments or small schools)—in determining whether mid-career entrants and their colleagues have opportunities to exchange their respective strengths.

Technological infrastructures: Participants' former worksites, in addition to having effective physical layouts, had technological infrastructures that facilitated the kinds of interaction that their jobs required. These infrastructures allowed participants to communicate with colleagues on their teams, as well as with those in other departments or geographic locations. In addition, centralized databases and intranets allowed coworkers to organize, archive and share resources, such as reports that had been presented to prior clients. In several cases, participants' former organizations had developed their own networks to enable the efficient exchange of information between employees throughout the country. Roy explained:

> The small, efficient, flexible companies [where I worked] knew that collaboration among the engineers was the key to being proficient. We knew that the advantage of getting the collaboration to be technically supported would be much greater efficiency on the part of the whole company. So there was never anything that tried to get in the way of that. In fact, some of the things that we did were ground breaking. We set up a way for the engineers who were working in Boston and Baltimore and Los Angeles to all share the code that they had written. People who grew up in the era of the Internet think, "What's the big deal?" But, in fact, there was no network. We had to build a network, and we had to write software that would take all the changes that had been made at one site and relay them reliably to the other two sites and do that in all six directions. And it was entirely so that we could collaborate better.

Kate and Carter's former companies provided less sophisticated examples, which were, perhaps, more indicative of the technological infrastructures in typical organizations in math- and science-related industries. At Kate's former worksite, employees could access centralized databases of materials (reports, contracts, etc.) as well as folders where they could organize, archive, and share work that needed to be integrated. At one of the software companies where Carter had worked, teams had virtual meetings or online discussions when their work required performing tasks, such as brainstorming, which were suited for online forums.

Some participants, like Marcia and Joe, described having access to technology that helped them organize and carry out their work in the classroom. However, no participants described having access in their schools to technology, outside of e-mail clients, that facilitated interaction among colleagues. Carter explained:

> We have no technology that allows [us to interact with other teachers]. There are four or five PC's that are able to access the network, but they're old technology, they're very slow. There are one or two printers that sometimes work, but which most recently have not been working. And there's very little paper… it's ridiculous. There's definitely nothing like a computer on every desk where you could put your lesson plans and share them with other teachers in a news-room type setting. Not only do we not have the capability of doing that, we don't have the vision to do it, which is even more serious.

Carter saw great promise in the use of technology in education were schools able to secure the resources. "Imagine a case," he noted enthusiastically, "where you bring in a new teacher and you can share lesson plans and handouts in electronic form, and you have a printer in your own room and can just print them off…"

Several participants reported that the lack of technological resources at their schools also made it difficult to apply the technological skills they brought from their former careers towards constructive ends. For instance, Kate reported that the lack of resources in her classroom, and the difficulty of gaining access to the school's computer lab, meant that her technological skills were gradually slipping. "I'm definitely losing my skills," she lamented, "technology is one thing that I'm losing over time here."

***FINDING #3*: Participants satisfied in teaching despite limited interactions**

Participants acknowledged that there would likely be many benefits associated with mid-career entrants and their colleagues having more opportunities to share their respective knowledge, skills and resources. Indeed, as described in the previous section, many participants longed for more opportunities to interact with their teacher colleagues and for the kinds of structures and organizations that would support these exchanges. However, the limited interaction that participants encountered in teaching did not appear to have compromised their general satisfaction in their new career. The reasons for this appeared to have much to do with the role that the culture of their former and current worksites played in affecting participants' overall satisfaction.

Half of the sample reported having been generally satisfied in their former careers and with the nature of their interactions with colleagues. The majority of these participants entered teaching out of an interest in doing either: 1) more meaningful work, or 2) work that allowed them to have more time with their families. The other half of the sample, however, reported that the competitiveness and intensity of their former worksites undermined the interactions that their work required and compromised their overall satisfaction in their careers. Thus, despite nearly all participants reporting that the interdependent nature of their former work—and the organization of their former worksites—were well suited for advancing organizational goals, half of the sample had not particularly enjoyed interacting with their peers. Given the trade-offs between their current and former careers, many participants found their interactions as teachers—infrequent, optional and informal as they were—preferable to their interdependent, but intensely competitive, former careers.

Carter, one who had grown dissatisfied in his previous career, described how the motives and competitiveness of his former colleagues eroded his sense of satisfaction with the software industry:

> I really didn't like the people I was working with. They were fairly greedy. They were looking at it from the standpoint of how much they personally could get, as opposed to building a business that would benefit a lot of people... It's a competitive industry. Whereas my modus operandi was one of collaboration, I found that many of my peers didn't really want to collaborate. They would withhold information. They would withhold cooperation. Frequently they would go behind my back and try to make me look bad to make themselves look good. And I got tired of that.

Similarly, Roy—who had worked in companies where the organizational cultures *were* stimulating and supportive—had also worked at several organizations where, "there was enough tension in the environment to make it the money that [he] was working for instead of the environment." At one organization in particular, the culture was so intense that Roy resorted to listening to Garrison Keillor's *Lake Wobegon Days* on his way to and from work. "That was the level of humanity I needed to counter the tension level at work," he explained. While Roy had generally enjoyed his work as a programmer, nearly two decades in the business had led him to conclude: "Engineers aren't the greatest repository of human warmth and kindness." Jerry was also among those who had tired of the competition in their former careers. He reported:

> [At my former organizations], there was always the feeling that some people had to be one-up on you because their goal was that supervisor's spot or that manager's spot. My goal was to go in, be the worker bee, and get the job done. I didn't necessarily want to be a manager-type person (though Jerry had performed managerial roles during his career). There were a few people in your department

> that you collaborated really heavy with, and you got along well with. You could confide in them about where you were at with a particular job and they would work with you. And then there were other people that you didn't let on… you played your cards really close to the vest because you were afraid of what they would do to get one-up on you.

Shelly had also been driven from her former career, biological research, because of the competitiveness of her laboratory. She explained:

> The competitiveness in the lab, because everyone was so career bent, wore a little thin after a while. That's why I eventually left the lab. The field was very, very hot. [The competitiveness] was out of necessity. To stay hot, the lab had to be very competitive. And it was always very important for people to be the first to publish, so we were competing with labs all over the country. Within our lab, there were some egos involved. There were a lot of people who were, understandably, most interested in what they were doing and how other people could help them. And it's not as if they were horribly selfish and would not then help other people, but there was a degree of every-man-for-himself.

Participants who had been partially or wholly dissatisfied in their former work found that their interactions with their teacher colleagues, while briefer and less frequent that those in their former careers, were generally more rewarding. For instance, Jerry felt that the culture in his school was "a lot different" than those in the high-tech organizations where he had worked. As a result, rather than playing his "cards close to his vest," Jerry felt that he could interact freely with his teacher colleagues. He elaborated:

> With the teachers, there's not that level of one-upsmanship. There's nobody, at least from what I can see, trying to be better than somebody else. They're trying to be the best that they can be for the sake of being a better teacher, not for getting that management or supervisor position. The working together, the camaraderie, is much better. I've had people come in [to my classroom] and say, "If you need any help, let me know. Whatever you need, let me know." And you don't feel afraid to say to them, "Jeez, I was doing something in my classroom that wasn't working… did you ever do anything like this or what did you do?" And they'll tell you. There's a lot more sharing going on. There's more of a feeling of we're all in the same boat and we'll try to make it work.

Similarly, Shelly said of her science department colleagues: “they’re the most collegial, collaborative people I’ve ever worked with in any circumstance. Everyone is enormously generous with their time, expertise, and materials.” Carter expressed similar sentiments when he remarked:

> My experience is that it’s a lot easier to collaborate with your peers [in teaching] than it was when I was in business. Teachers are a lot more interested in learning and growing than most software executives are. So I’m finding [teachers] just a more pleasant group to work with.

<u>FINDING #4</u>: Participants neither reinvent their worksites nor settle for status quo

Faced with the discovery that their new careers involved independent work in schools where organizational realities constrained interaction, participants neither attempted drastic reforms of their worksites nor did they settle into lonely classrooms and accept the status quo. Most worked within the constraints of their schools to maximize informal contact with colleagues. Several took more deliberate measures to satisfy their desire for interactive work.

Nearly all participants, regardless of whether they had been satisfied in their former careers, attempted to combat their isolation in teaching by increasing their informal interactions with colleagues. Participants’ efforts in this regard ranged in their level of ambition and creativity. Shelly, Joe, Marcia and Roy all took the simple, but deliberate, measure of eating lunch in a location, such as a department office or cafeteria, where they were more likely to strike up conversations with colleagues. Joe willingly signed up for a hall monitor duty simply because it placed him in a location where it was easy to strike up informal conversations with colleagues. While these interactions may not have been substantive enough for participants and colleagues to share their respective capabilities in depth, participants did find them personally and professionally valuable. Occasionally, these informal interactions developed into subject-related discussions from which participants and their colleagues learned much. Shelly described typical lunchtime banter:

> We'll go from talking about people's kids to vacations to physics, to chemistry… we're just all over the place. One day, the lunch-time conversation in the science office consisted of teachers trying to calculate whether blood would hit the ceiling if somebody punctured their carotid artery and were lying on a table… The physics teachers were trying to calculate the fluid pressure and the biology teachers were trying to figure out what this had to do with blood pressure…

Several participants looked towards the summer as a time when they could interact with colleagues in more depth at school-sponsored professional development sessions or in meetings that they arranged on their own. Marcia, for instance, spent one summer working with colleagues in the chemistry and social studies departments to design courses on incorporating technology into the classroom, a strength Marcia had developed in her work as a sales support engineer. For the upcoming summer, Marcia and her colleagues were developing a week-long professional development seminar for which attendants would receive in-service credit. Similarly, Kate and one of her math department colleagues had gotten together during the summer to figure out how they could use a statistical software package to strengthen their instruction.

A small handful of participants seemed intent on making the dynamic within their departments more interactive. Even participants who went to such lengths did not seem disheartened by the need to do so. For example, both Peg and Joe pursued external grants, the planning and execution of which required interacting with members within and outside of their departments. For Peg, applying for grants was not just a way to bring resources to her department but was a tool she used to keep from becoming isolated in her work. “I write grants to get money to buy supplies and to develop curriculum,” she explained, “and then I try to include at least two or three other people in that grant so it gives us an opportunity to collaborate.” Similarly, Joe found that applying for technological grants brought him into contact with other colleagues in his school (those in the technology department) and provided him with more opportunities to utilize his technological skills in his new career.

CONCLUSIONS & IMPLICATIONS

Conclusions

The evidence from this study supports the commonly held assumption that math and science mid-career entrants are an attractive source of supply for hard-to-staff teaching positions. In their prior careers, many participants gained valuable, practical experience working directly with the kinds of mathematical and scientific processes they are now teaching. Even those whose former work did not require extensive application of their subject areas reported having developed the kind of analytic thinking that undergirds their subject areas. Further, in order to succeed in their competitive first careers, all participants had pursued undergraduate or graduate degrees in their field, meaning that preparing to teach involved reviewing subject material rather than learning it for the first time. Though it is difficult to separate out the skills and knowledge participants gained from their work experience from those that were developed during their undergraduate or graduate training, the net effect of both experiences left all but one participant feeling well prepared to teach their subjects. In addition to their subject-related strengths, participants brought a familiarity with technology, communication and presentation skills, and grant-writing capabilities, which further supported their work as teachers and brought resources to their schools.

Participants reported that there were numerous benefits associated with the knowledge and skills they brought to teaching. Beyond these tangible benefits, however, participants' knowledge and skills seemed at least partially responsible for the apparent ease with which they entered teaching. While my interview protocol did not ask participants to describe their career transitions at length, it was evident that their prior work experiences and the skills they gained from them had helped participants adapt to their new schools and career relatively quickly. More specifically, participants reported having strategies for dealing with many of the aspects of teaching that often frustrate or intimidate first-career entrants. Instead of lamenting the inadequacy of the textbooks at his school, Carter developed classroom exercises based on the scenarios he faced as a mid-level manager in the software industry. Rather than getting rattled when a parent challenged him during a back-to-school presentation, Roy relied on his skills as a manager to remain calm and in control of the conversation. Despite the fact that half of the sample worked in schools where organizational supports—such as comprehensive curricular materials, new teacher induction programs, scheduled planning periods with colleagues, and adequate technological resources—seemed minimal, all participants described being generally satisfied in their new careers and in their schools. In colloquial terms, it appeared that participants' backgrounds had allowed them to "hit the ground running" upon entering teaching.

The second major finding of this study is that most benefits associated with math and science mid-career entrants' presence in the teacher workforce are likely to be confined to their own classrooms. The isolated nature of teaching and the organization of the schools in this sample appeared to offer mid-career entrants and their colleagues few opportunities to exchange information about their respective strengths. The general lack of interaction is quite likely a disservice to all teachers, mid-career and first-career, novice and veteran. Experienced teachers may not have occasions to learn, for example, how technology could enhance the organization and execution of their work. And mid-career entrants may be left largely on their own to learn, for instance, the finer points of classroom management. Some participants took measures—such as securing grants for technological improvements or planning summer professional development workshops—which might lead to benefits beyond their classroom walls. However, most participants focused their efforts on their own instructional objectives. Thus, while it appeared that participants possessed the kinds of knowledge and skills that might help enrich and improve math and science instruction throughout the school, the organizational structures, physical layouts, and technological infrastructures they encountered suggest that it will be difficult for math and science mid-career entrants to affect math and science teaching on a school, district, or national scale.

The isolated nature of teaching that was identified decades ago (e.g. Lortie, 1975) persists despite the increasing presence of mid-career entrants, some of whom come from highly interactive former careers. My findings suggest that—beyond the legacy of history—this reality may be the result of the interaction of many factors, including the organization, physical structures, and technological infrastructures of schools, and the preferences of mid-career entrants given their former work experiences.

Implications

This study has implications for practitioners, policy-makers and researchers interested in studying math and science mid-career entrants further. First and most obviously, my data suggest that school administrators should consider recruiting mid-career entrants to fill math and science vacancies because of the knowledge and skills they can bring. However, in doing so, administrators should anticipate that the benefits of math and science mid-career teachers may be limited to their classroom accomplishments unless administrators are willing to address larger issues (i.e. the nature of teaching and organization of schools) that constrain opportunities for mid-career teachers and their colleagues to share their strengths. Shifting the model of teaching from one of independence to one of interdependence is no small charge. Similarly, redesigning schools' structures and schedules in ways that allow colleagues to collaborate during the planning or execution of their lessons are monumental tasks. However, school- and district-level administrators may be able to increase the opportunity for interaction between teachers through far less drastic measures. First, encouraging teachers to observe each others' work and exchange feedback (and granting them the time to do so) might introduce mid-career entrants and their colleagues to new ways of teaching that spark constructive discussions about instruction. Second, while school schedules are notably complex, granting common planning periods to mid-career entrants and experienced teachers who are teaching the same classes would allow both parties to exchange valuable ideas and insights. Mid-career teachers might share, for example, some of the practical exercises they developed from scenarios they encountered in their former work. Experienced teachers might have helpful ideas about, for instance, how to modify the lesson for students with special needs. It seems important to emphasize that, while the mid-career entrants in this study reportedly appeared to handle many of the challenges of teaching well, they still enter the field, like all new teachers, with much to learn about their new work. By highlighting the knowledge and skills that mid-career entrants bring to teaching, I by no means wish to suggest that they are any less in need of the kinds of induction supports offered to first-career entrants.

If possible, changes to schools' physical layouts and technological infrastructures might also provide mid-career entrants and their colleagues more opportunities to share their respective strengths. Most obviously, granting teachers a department office might allow them to exchange subject-related tips informally throughout the day. In schools with space constraints, establishing even basic technological infrastructures with centralized hard drives, shared folders, and discussion threads might promote constructive interaction between mid-career entrants and their colleagues. For instance, in schools where it is difficult for teachers of the same subject area to meet—such as schools that are divided into smaller school units—teachers might be able to construct exams electronically, thus freeing up more time during department meetings to share instructional strategies or discuss curricular revisions. Given their familiarity with technology, math and science mid-career entrants may be well suited to offer advice on the design and implementation of such technological infrastructures.

Policy-makers can increase the likelihood that schools will capitalize on math and science mid-career entrants' strengths by incorporating some of these practical measures into their plans. Most policies thus far have focused on attracting math and science professionals to teaching (e.g. by creating incentives such as higher salaries or loan forgiveness plans) and easing their entry into the profession (largely through alternative or emergency certification programs). Getting more qualified math and science teachers into classrooms is undoubtedly an important step towards strengthening instruction. However, it seems unlikely that these new teachers will be any more likely to improve math and science instruction unless they and their experienced colleagues have meaningful opportunities to share their respective strengths and to work together on revising instruction. Simply put, policies regarding mid-career entrants should not just ease their entry into teaching but should insure that the resources exist within schools for mid-career entrants and their colleagues to share their knowledge and skills.

Much more research on math and science mid-career entrants is necessary before any definitive claims can be made about the effects of their presence in the teacher workforce. Large-scale quantitative studies (i.e. studies that analyze state- or national-level datasets) are needed to generate relevant descriptive information about math and science entrants, such as their undergraduate and graduate majors, the industries in which they worked, etc. Findings from such studies would shed light on, among other things, whether the capabilities articulated by participants in this study are likely to be representative of the strengths of math and science mid-career entrants in the larger population. In addition, large-scale studies of mid-career entrants who come from a variety of backgrounds and chose to teach a range of subjects might yield interesting findings about how math and science mid-career entrants differ from their mid-career counterparts in other disciplines. Causal quantitative research designs are necessary to address the fundamentally important question of whether math and science mid-career entrants are more effective teachers than their first-career counterparts. Additional qualitative interviews with math and science mid-career entrants' colleagues, administrators, and students might shed light on whether there are department-, school-, or district-level benefits associated with mid-career entrants.

Qualitative studies with larger samples of math and science mid-career entrants would undoubtedly refine the findings from this small-scale, exploratory study. Further, as this study focused on the skills and knowledge that mid-career entrants found useful in their work as teachers, additional research (qualitative and quantitative) should explore the areas in which math and science mid-career entrants may be deficient. For example, while participants in this study appeared to bring many capabilities to teaching, it is possible that the benefits associated with these strengths were partially, even largely, negated by deficiencies in other areas. A mid-career entrant might bring dazzling technological skills from his former career; however, the sophisticated presentations he creates with these skills may be of little benefit if he is unable to control the disruptive student in the back of the classroom. Lastly, more research is needed on the effects of collaboration in teaching and on the cultures, structures, and technological infrastructures that enable teachers to engage in the kinds of interactions that are likely to strengthen instruction and improve student learning.

Appendix A: Research Questions

The following research questions were specified in my qualifying paper proposal, "Understanding the Skills, Experiences, and Knowledge of Math and Science Mid-career Entrants to Teaching":

Research Questions

1) Why did participants (mid-career entrants from math and science backgrounds) leave their former occupations and enter teaching?

2) How do they compare and contrast their interactions with colleagues in their current and former contexts?

3) What professional skills and knowledge from their former work do they bring with them to their schools, and how—if at all—do they transfer these capacities to their new work?

Appendix B: Interview Protocol

1) First I'd like to briefly gather some background information about you and about the jobs you've held:
   - How many years have you been teaching?
   - How many years have you been teaching at this school?
   - What subject are you currently teaching?
   - How old are you?
   - What did you do before you became a teacher?

2) Tell me a bit more about your work as a (<u>name of job(s</u>)
   - What was your job title?
   - What was the name of the organization where you worked?
   - Where was <u>name of organization</u> located?
   - What were your responsibilities and duties in this role?
   - Where did this job fit within the larger structure of the organization?

3) Why did you decide to become a teacher?

   Probes:
   - *Satisfaction*
   - *Match between personality type and work responsibilities*
   - *Match between personality type and culture of work environment*
   - *Age/developmental stage*
   - *Financial considerations:* Did you take a pay cut to become a teacher? If so, how much? Where did your district place you on the salary scale?
     - *If salary is substantially less in teaching, ask:* "How have you made this career change work financially?"
       - *Probe for:* existence of savings from former work, pension, inheritance, etc.

4) To what extent did your work as a <u>name of job</u> require interacting with colleagues? Please describe the interaction you'd have with colleagues in a typical day…

If worked with others…

5) Was the collaboration effective for accomplishing organizational goals?

6) Was your organization (department, office, etc.) structured in a way that supported or inhibited the kinds of interactions you needed to have? Describe.

7) How did the people with whom you interacted (on your team, in your department) get along?

Probes:
- *was the culture collegial? competitive? combative?*
- *was rapport unique to group or characteristic of the larger organization?*

8) How did your work with others in this job affect the way you felt about the position overall?

If worked in relative isolation…

- Would more interaction with colleagues have been helpful given the tasks you needed to accomplish? If so, please describe which tasks would have benefited from a greater degree of collaboration.

- Did the way your organization (department, office, etc. as is appropriate) was set up affect the way people interacted? Describe.

- How did the isolated nature of your work affect the way you felt about the job overall?

9) How would you compare the way you worked with others at <u>name of organization</u> and the way you work with your teaching colleagues now?

10) On what kinds of projects/initiatives do you collaborate with colleagues? Teaching?

11) Is your school organized in ways that promote or inhibit working with colleagues?

    Probes:
    - *Effects of "house" organizational structures, grade level teams, planning schedule (do teachers have free periods in common?), physical space, departments, etc.*

12) Are your collaborations with your teacher colleagues fruitful?

13) Does this collaborative/isolated nature of your new career affect how you feel about teaching?

14) Are there skills and knowledge that you developed in your former work that have proven useful to your work as a teacher?

    If useful skills/knowledge from former work…

    Probes:
    - *Members*
    - *Tasks*
    - *Tools*

If no useful skills/knowledge from former work, skip to Question 16

15) Have you had to adapt these skills and knowledge to make them relevant to teaching? If so, describe…

Probes:

- *modification of subject knowledge*
- *use of skills/scenarios in teaching*
- *use of strong ties/relationships at school to modify knowledge and skills. Have these people volunteered knowledge or has the participant had to seek it out?*
- *technologies from former work*
- *complex or simple knowledge?*

16) What skills and knowledge from your former work have not transferred to teaching? What have you had to learn?

17) To what extent do you feel your school is tapping the relevant skills and knowledge you bring from your former career?

Follow-up:

- *Opportunities to share expertise with colleagues?*
- *Which skills and knowledge have gone untapped? Why?*

18) Which job have you found more satisfying overall? Intellectually challenging?

19) Lastly, most teachers enter the classroom as their first career. How has your experience made it easier/harder/different for you than for people who enter the classroom right out of college?

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