SPOTLIGHT ON EDUCATION PROFESSIONALS IN THE SCHOOLS –
YESTERDAY, TODAY, AND TOMORROW (SEPPS):
A REVIEW OF THE LITERATURE TIED TO DEMOGRAPHICS, STAYERS, MOVERS, AND LEAVERS

Demographics Characteristics and Career Paths for Science Teachers in Secondary Schools:
A Review of Literature

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Introduction

There is optimism about the future. Scholars from a variety of disciplines are conducting more research than ever on teacher education... We must continue to openly discuss and debate the role of teacher education in a democratic society such as the United States (Cochran-Smith & Zeichner, 2005, pp. 756-757).

This manuscript examines the scholarly literature to shed insight into the demographics characteristics and career paths taken by secondary science teachers.

In 2005, Cochran-Smith and Zeichner edited the seminal book, Studying Teacher Education: The Report of the AERA Panel on Research and Teacher Education, which examined characteristics of our nation’s teachers, where they teach, and the influence of demographic variables. Gaining an understanding of how these and other factors relate to the progression of teachers’ career paths is critical, as Cochran-Smith and Zeichner report an average teacher turnover rate of 30 percent, with 6 percent never returning to the profession.

With the dean and associate dean professing interest in determining the influence of school of education alumni in the schools and on student learning, the Neag School of Education (herein, Neag School) at the University of Connecticut introduced an initiative -- A Spotlight on Education Professionals in the Public Schools - Yesterday, Today, and Tomorrow (SEPPS). This initiative includes a review of literature (including information from professional organizations, NCES, AACTE, state departments, journals, etc.) of the demographic characteristics and career paths that are representative of educators from each field. This review would provide information such as background characteristics (including gender, race/ethnicity, age, type of employment), factors prevalent among stayers, movers, and leavers, and projections of future trends in the
field. While Cochran-Smith and Zeichner’s (2005) piece is now considered seminal, in many ways the information in this manuscript and accompanying documents updates the information from that 2005 book, and further elucidates field-specific teacher data (e.g., elementary, bilingual, world language, and music education). It also includes information about educators who are not teachers – including school counselors, school psychologists, and principals. Also, throughout this manuscript, we borrow from the writing of Billingsley (1993) in the area of special education to apply to the terms used across educators in all fields. As recommended by Billingsley (1993) and now illustrated in figure 1, “stayers” (retainees) is the label given to those who remain in the same position in the same school between school years; “movers” (transfers) refers to those teachers who stayed in a position but transferred to another school (in the same or a different school district), or who transferred to another type of teaching position; and “leavers” includes those who left the profession, for reasons such as retirement, finding another job in a different field, returning to school, or taking a job other than teaching at the school (e.g., school administration).

Figure 1: Educators’ career path as stayers, movers, and leavers.
Science Teachers

Science education has played a crucial part in the advancement of society throughout history, and the field grown alongside the technological progress of the modern world. Because all scientific thought and revolves around the process of inquiry, which entails the desire to learn and question science (Hofstein & Lunetta, 2003), so too should science education be rooted in the teaching of inquiry skills. The constant questioning and revision that is inherent to science itself has led to the creation of an educational discipline that is always forward moving, resulting in new opportunities and reforms in science education (Schneider & Krajcik, 2002). Inquiry as taught in science education, attempts to instill in students the desire to learn scientific theories, history, and purpose. The use of open labs in science education is a method of inquiry-based learning in which students are encouraged to explore and discover answers independently. This introduces a new level of confidence among students, helping them to develop more self-efficacy in their abilities to succeed in science. (Hofstein & Lunetta, 2003). The process of students’ reaching independence is a gradual one. Teachers take the lead in the beginning of the process, then slowly release control as students gain the confidence to move through the steps and take greater responsibility for their learning.

In order to facilitate students’ learning through inquiry in science education, secondary science teachers need a high level of science literacy. Science literacy is a process that must be scaffolded, and given that the literacy requires different skills in each field, educators need to teach discipline-specific scientific literacy (Matthews, 2000). Secondary science teachers following the National Science Education Standards have the goal for all students to also reach a level of scientific literacy, which, in science, is viewed as the ability to “achieve knowledge and understand the world” (National Research Council, 1996).
To teach scientific literacy to students, teachers must themselves be able to explain their interpretations of science literature and texts, modeling for students the proper way to become scientifically literate (Matthews, 2000). As students gain literacy in science, inquiry is naturally facilitated through the process of learning to comprehend and synthesize outside sources and to materialize their thoughts in writing (Schneider & Krajcik, 2002). Therefore, inquiry and literacy go hand in hand, allowing students to find results on their own and reflect upon their findings with peers. This allows collaboration towards the advancement of technology and scientific advancement, which is the backbone of science education and practice.

**Demographics of Secondary Science Teachers**

Despite the conception that males dominate science, the Digest of Education Statistics shows that 53.8 percent of natural science teachers were female in 2007, which shows that there is a fairly even distribution of males and females in general science education. Representation of females in the field helps to promote the idea that science is a viable occupation for them in the future and that anyone can engage in science.

The same national survey shows that the majority of science teachers are white, accruing for 86.4 percent. Meanwhile, only 5.5 percent of science teachers are black and 4.2 percent are Hispanic. The remaining 3.9 percent for the year accounts for all remaining races. This shows that there needs to be a greater level of engagement in science from persons of various ethnicities.

One factor that may influence the shortage of ethnically diverse science educators is the high frequency with which science teachers leave ethnically diverse schools and move to suburban districts. Therefore an increase in quality science teachers in urban districts could contribute to greater diversity in science educators.
There was also a fairly even distribution of natural science teachers across different age brackets, in 2007. The “over 60” age bracket had the lowest representation (7%), followed by the under 30 bracket (17.2%). Each of the other 10 year brackets (30 to 39, 40 to 49, and 50 to 59) comprised between about 25 percent of the science teacher population. The relatively lower percent of teachers under the age of 30 may be because science teachers leave the field within five years, as suggested earlier (Gilbert, 2011). A shortage of science teachers can occur when younger science teachers, who are supposed to fill the gaps left by the older generations retiring, leave the profession for a more lucrative career.

**Culture of Secondary Science Education**

Historically, the field of science education, and the science teachers within it, have had difficulties with student engagement. It has been suggested by Matthews (1994) that teachers may need to adjust their practice in several ways in order to increase student interest. To help students gain more appreciation for the laboratory process, teachers can instill the ideals behind science through teaching students its history and philosophy. To effectively teach this, Mathews (1994) feel that teachers will need to have an understanding of scientific history and how science has shaped the progression of our society and culture. Matthews explains that teaching science alone, independent of context, will not gain the interest of many students, though it can stand alone as a course. Instead, it is suggested that students receive a course on either the philosophy or history of science, or that this knowledge is woven into other science courses. For example, providing the background story of how Watson and Crick helped to discover the double helix structure of DNA, and what other discoveries and innovations this later led to, may excite some biology students more than simply teaching about what DNA is and what it is made of.

Similarly, in learning about geology, students can learn more than just the process of how fossils
are formed. A teacher could have in depth discussions about the history of a particular fossil record and the controversy behind existing theories. This can broadens students’ thinking into other scientific concepts, such as evolution, and can also open the door to deeper reflection, debates, and other activities that heighten engagement.

**Movers and Leavers**

Most secondary science teachers that leave are within their first five years of practice. According to the National Center for Education Statistics (NCES), approximately 40 to 50 percent of new teachers leave the field entirely within those years (Gilbert, 2011). Among this group, 25.5 percent leave within the first three years, 32 percent leave between the third and fourth years, and 38.5 leave between the fourth and fifth years (Bang et al. 2010; Gilbert, 2011).

The National Science Foundation investigated reasons and patterns behind the attrition of science teachers specifically within the first five years fields in a study of 115 beginning educators. Fifty percent of the teachers were teaching only in a subject area they had previously studied (*i.e.*, biology teachers had studied biology, chemistry teachers studied chemistry), while 30 percent were teaching out of their subject area. An additional 20 percent were teaching multiple fields throughout the year, including one they had previously studies (Bang et al. 2010).

Bang et al. (2010) further found in their study that 83 of the 115 (72.2%) of the beginning teachers continued with the same position, while 23 teachers were either voluntary or involuntary movers. Most of the involuntary movers were forced to move due to poor performance, and most of the teachers who were moved had been alternatively certified. The researchers also wanted to determine if there was a difference in the number of teachers who moved or left middle schools versus high schools, but no significant difference was found.
These researchers sought qualitative data to identify possible reasons for moving or leaving. They found certain instructional practices and leaving were related. Teachers who gave less instruction to the students when preparing them for the assignment or task to be completed were more likely to leave. They were also observed to be using fewer resources. Both practices can be detrimental in science, as detailed instruction, modeling, and materials and are often needed to fully understand concepts and to gain the expected outcome. Minor gaps in instruction can result in misinterpretation of data and students not gathering the knowledge they need to move on. If poor instruction occurs and few resources are utilized, students can easily fall behind, which slows the progression of the class. This can cause stress to the teacher which may contribute to his/her leaving. Conversely, the teachers who spent less time instructing students on tasks or who were less resourceful in using materials may have already been disengaging from their role as teacher. The lack of attention to the students may have been an outward manifestation of lower commitment and might have been read as a sign that they were more likely to leave in the future.

In the same study, it was also found that the majority who left did so around the month of February, and two reasons are provided to account for this. First, the time right after winter break is when the testing focus is often heaviest, and it is believed that teachers become stressed and overwhelmed with this responsibility. The second reason are behavior management issues that tend to crop up directly after testing occurs. Feeling relieved to be through with testing, some students may sense they no longer need to pay attention and others feel the need to “let off steam”, leading to more unruly behavior.

Gilbert (2011) has found that classroom management problems can pose a particular challenge in the science lab for the secondary science teacher. Directions by the teachers should
be stated such that the students can followed closely to complete activities within an allotted time frame. If classroom structure and procedures are not maintained, chaos can quickly ensue, which can cause a great deal of stress for science teachers who lack strong classroom management skills. Thus, with more stress, the tendency to leave the professional could be impacted.

Science teachers are known to transfer from lower paying areas to higher paying ones, and teachers with higher than average test scores were more likely to leave the field permanently (Lankford, Loeb and Wyckoff, 2002). Additionally, Rumberger (1987) has found that salary is believed to be a contributing factor for both movers and leavers, as science educators’ transition to districts where the compensation is better or seek more lucrative careers. Therefore, it has been suggested by Rumberger that higher salaries will decrease the number of leavers.

It has also been suggested by Imazeki (2005) that supporting science teachers would prevent such high rates of attrition. If attrition rates decreased, there would be a significant increase of science teachers, given a higher level of retention since there is no shortage of teachers entering the field. A nine year study by Imazekion attrition in Texas showed that the attrition rate among science teachers is 16 percent, which is slightly higher than other subject areas, which average about a 14 percent rate.

Attrition of science teachers has especially serious repercussions in both rural and urban districts with students of lower socioeconomic and high volumes of transfers. In a study in Wisconsin, Imazeki (2005) found that the rural districts had 19 percent of their teachers move to other districts, and only 12.5 percent loss of teachers transferring in suburban districts. This study also has data from the 1990’s which concluded that fewer of the teachers in the Milwaukee area had previous teaching experience in comparison to suburban districts. Meanwhile the suburban areas in Wisconsin replaced 50 percent of the teachers lost (from moving or career
change) with teachers who had experience and were transferring from other districts. In this study it was concluded that data supported their hypothesis, showing inexperience is coupled with socio-economically challenged students.

The counter shows that more experienced teachers hold a positive correlation with students’ performance in the classroom. The study concluded that 59.5 percent of the new hires between the years 1992 to 1998 had no previous experience, while only 40.5 percent had previous experience in the classroom. At the same time suburban districts had lower numbers of new teachers with no previous experience. The suburban districts had 51.6 percent of new hires with no previous experience, at 7.9 percent lower than urban districts, which means they hired 48.4 percent teachers with experience compared to the 40.5 percent gained in suburban districts. Coupling this data, urban districts had a higher number of new teachers than suburban (Imazeki, 2005). There were only 5.8 percent new hires in suburban schools compared to the 6.9 percent that were hired in urban schools. This shows that science teachers are lost at a higher rate in urban schools and are being replaced with approximately 40.5 percent experience level compared to the loss. The loss in science could be crucial given the lack of experience that is replacing teachers who either left or transferred.

**Cause and Repercussion for Attrition and Transfer**

But what may be the cause and repercussion of secondary science educators?

Higher attrition rates among science teachers who had better test scores than average were more likely to leave education permanently (Imazeki, 2005). Given that transfer levels are high among science teachers, it is areas that have trouble paying science teachers the same level of salary that causes most loss. This could pose the largest problem for schools that have trouble retaining science teachers, when the field of science is already one that is in demand. This is
shown particularly in urban and rural districts. According to Imazeki, urban and rural districts with low-income students have the concern of losing teachers to other districts with openings.

Attrition and transfer could have very serious repercussion for schools with high volumes of loss or transfer. When high volumes of transfer or attrition occur school are more likely to fill gaps left by experienced or reputable educators with teachers who are not as qualified.

**Shortage of Science Educators and Proposed Solutions**

Throughout the 1980’s science education, it was estimated by Matthews (1994) that approximately 600 science teachers would enter the field while 8,000 would leave. In 1986 there were approximately 7,100 secondary schools with no physics program and 4,200 with no chemistry classes. Four years later there was little progression in the field of science education. Some feel that there was little recognition of the importance of science in the high school curriculum as fewer than one in five schools required students to take three science classes during their time in high school (Matthews, 1994).

The struggles faced by the field during those years contributed to the shortages of science teachers we are still seeing today. The field of science education is currently unable to replenish teachers at the same rate of which they retire (Ingersoll & Perda, 2009). The decrease in numbers of science teachers coupled with the increase in demand, given the increase of student enrolment poses a problem. With the increased push for science, and lack of science teachers to fill the gaps, there is a fear by those such as Ingersoll and Perda (2009) that the quality of science education will decline. This may leads to unqualified teachers filling science positions, and decreasing the level of academic rigor in science.

In response, Ingersoll and Perda (2009) state that reforms are attempting to create a greater number of qualified science educators. In 2006, President Bush called for 30,000 new
educators for the field of science in his State of the Union Address. Funding for the initiative was provided through the No Child Left Behind Act. Another attempt to improve science education comes through the Obama administration’s federal investment in Science, Technology, Engineering, and Mathematics (STEM) education. The administration has prioritized STEM education by directing $180 million dollars to the U.S. Department of Education, the National Science Foundation, and the Smithsonian Institution in an effort to improve K-12 education and other areas. The administration has the goal of preparing 100,000 STEM teachers through the STEM Pathways Program to work in high need, while programs such as Troops-to-Teachers have been developed to recruit professionals from other science fields and transfer them to education programs as a career alteration. In this case, professionals would have the opportunity to begin teaching immediately and possibly foregoing further education training towards certification. The STEM Master Teacher Corps has been proposed as an incentive program that will reward leading math and science teachers with additional compensation and membership in an elite group in exchange for providing their leadership and service to the field. Other incentives include signing bonuses, loan forgiveness and tuition reimbursement in attempt to fill educator gaps in science, with bright individuals. Many programs developed under the STEM education improvement strategy have been specifically designed to close achievement gaps and better serve underrepresented minority students.

**Who are the Science Secondary Level Teachers of Yesterday, Today and Tomorrow?**

Science has many roles beyond the classroom, and preparing students is simply where science begins. It is of utmost importance that students learn the many realms that fall under the category of science education with teachers that are well-verse in science literature and technology. This includes the history and use of science beyond the classroom, where skills and
tools are applied to the advancement of technology. For the continuing advancement of science and technology, there need to be certified and skilled teachers in the classroom. Many science teachers tend to move to suburban regions, leaving a shortage in socio-economically challenged regions. In these areas with a shortage of science teachers, other teachers who were not originally certified in science tend to fill in the gaps. This poses a great concern, as urban regions will have science teachers who do not fully understand science beyond the content. We can make sure that there are some policies to ensure students who will have the proper understanding of the contributions science can make would be those coming from urban regions. This shows the importance science teachers play and why their roles are as crucial as they are.
References


