

Looking Within: Proactive Staffing Strategies for Secondary School Administrators Experiencing Physical Science Teacher Shortages

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Introduction

Over the past decade, a national shortage of qualified teachers in the STEM disciplines has become increasingly emergent. As the day-to-day reality of this impending crisis reaches secondary schools around Pennsylvania, school administrators are faced with unfilled professional teaching vacancies placing their schools, programs of study and students in a disadvantageous position. The Pennsylvania Department of Education's (PDE) Act 82 of 2018 portrays a humbling visual of the high-needs areas of physical science and chemistry. It states that only one physics and 17 chemistry certificates were issued to in-state candidates after completing initial teacher certification programs from post-secondary teacher preparation programs across the commonwealth (Act 82, 2018).

Background

While school leaders may take a defensive stance related to this crisis, growing data paints a bleak portrait of pre-service science, technology, engineering, mathematics (STEM) teachers in training. The lived experience of numerous school administrators portrays a scenario in which Advanced Placement and College in High School courses rest in the balance of an applicant pool that has shown steady decline over the past 10 years. As career

opportunities burgeon in science, technology, engineering, arts and mathematics (STEAM) fields, targeting candidates with quantitative capacity, school leaders should expect even greater challenges to lie ahead in light of the already grim outlook for hiring classically trained physical science teachers. Moreover, the wave of impending teacher retirements is exacerbated by the uncertainty of contract negotiations and early retirement incentives and the prospective toll they will take on STEM classrooms.

The authors of this article challenge secondary school administrators to assume an offensive posture in the face of this troubling scenario. Notably, it may be both prudent and economical to look within the local school district to identify viable pathways for teachers in the STEM disciplines to acquire add-on certifications by taking and passing the applicable content area PRAXIS II exams.

While classical training pathways leading to certification unarguably are the purest approaches for certification (e.g., physics majors who seek initial licensure in an undergraduate or graduate program), the dearth of applicants does not afford schools the luxury of sitting and waiting. It should be noted that while PRAXIS II content exams in the three greatest subject areas of need - mathematics, chemistry and physics - are not unduly easy, the scope of the subject matter assessed within these respective exams does not reflect the rigor of 300- and 400-level, upper division course content.

In many small and/or rural schools, it is not uncommon for the secondary schedule to include only one or two sections of a physical science elective course. Given the lack of candidates in training and the employment costs associated with hiring new teachers, hiring a new teacher to



instruct only a portion of a full teaching load may not be cost effective. With school districts increasingly requiring faculty members to hold multiple certifications, school leaders are behooved to consider the potential of identifying current educators to add certifications in high-need content areas.

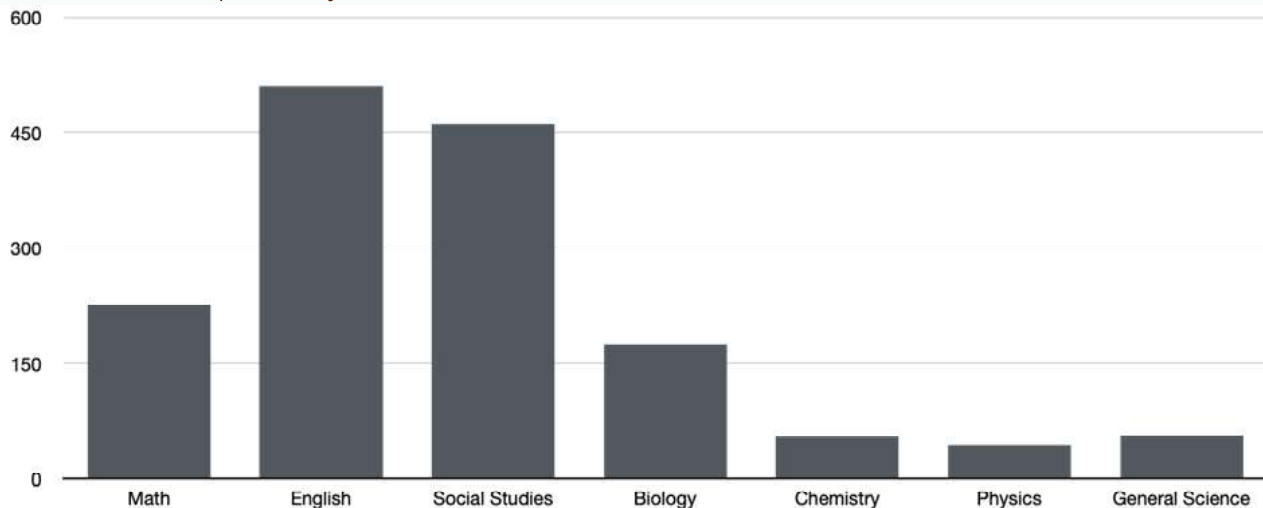
Pennsylvania is experiencing significant teacher shortages, especially in select high-need areas, including special education, math and science (Darling-Hammond, 2022). In addition to this, the number of newly certified teachers in the commonwealth has decreased annually over the past 10 years, going from 21,045 new Instructional I certificates issued in 2010-2011 to 7,695 issued in the 2020-2021 year (Act 82). Although the focus of this article is not to speculate about the cause of the shortage, it is worth noting that the steep decline in level I teacher certifications began around 2012, the same year in which Act 82 linked 50% of teachers' annual evaluation scores to students' performance on standardized tests. As a result, the authors recommend that additional research into a potential correlation between these two events be conducted. Further, according to data from the PDE, physical science level I certifications are among the lowest issued within core subjects (Act 82, 2018). **(See Figure 1)**

is not required prior to taking the associated PRAXIS II exams for most add-on certifications. During the 2021-22 school year, more add-on certifications were awarded in chemistry (18) and physics (14) than traditional certifications issued following classical training programs (Act 82, 2018). Ideal candidates for seeking an instructional add-on certification include teachers with physical science or mathematics certifications given their commonly shared quantitative and mathematical background (Bialek & Botstein, 2004). Individuals with initial certifications in biology or general science also may be viable candidates.

The instructional add-on strategy for certification introduces the challenge of preparing for the associated PRAXIS II exam. Every candidate requires different levels of preparation for the PRAXIS II based on his or her background and learning style. Additionally, an understanding of how the test is structured and a solid grasp of the relevant content are critical for success.

A variety of resources are available to help educators who are pursuing an instructional add-on certificate in the physical sciences beyond the realm of traditional paper study materials. While it would be ideal for educators potentially seeking additional certifications to take

Figure 1 - PA Teacher Certifications by Content Area 2020-2021



Of the most recent certifications issued by the Commonwealth of Pennsylvania, fewer than 100 per year (over the previous three years) were for physics or chemistry (Act 82, 2018). This leaves school leaders grappling with how best to staff physical science classrooms when job advertisements are met with no qualified applicants.

Proposed Solutions

A cost-effective, pragmatic option schools can utilize is the instructional add-on certification available for teachers already employed by the district. Instructional add-on certificates allow currently employed teachers to instruct classes outside their original certification areas at no further cost to the school district, as additional coursework

postsecondary courses within the associated content area, often, this is neither time nor cost efficient.

Resources

A valuable resource that may be beneficial to teachers seeking certification in the physical sciences is veteran teachers already working in the field. These teachers are content area experts who have the gift of being able to disseminate complex information in a manner that is accessible to others. An added benefit is that teachers may feel more comfortable approaching peers with questions that they otherwise may be unable to answer. This also can strengthen professional relationships that may be leveraged later on.

It is important to note that the Praxis II exams for chemistry and physics were revised as of September 2022. Updated breakdowns from ETS are provided in **Figure 2** (ETS, 2023). Knowing exactly what material will be covered on a given examination is critical for prospective test takers in order to become as well-prepared as possible.

Figure 2 - PRAXIS II Chemistry and Physics Exam Breakdowns

Test Name	Chemistry		
Test Code	5246		
Time	2 hours 30 minutes		
Number of Questions	125 selected-response questions		
Format	The test consists of a variety of selected-response questions, where you select one or more answer choices, and other types of questions. You can review the possible question types in Understanding Question Types.		
Test Delivery	Computer Delivered		
	Content Categories	Approximate Number of Questions	Approximate Percentage of Examination
	I. Nature and Impact of Science and Engineering	17	14%
	II. Principles and Models of Matter and Energy	31	25%
	III. Chemical Composition, Bonding, and Structure	25	20%
	IV. Chemical Reactions and Periodicity	29	23%
	V. Solutions and Acid-Base Chemistry	23	18%
<i>Half or more of the questions integrate a Science and Engineering Practice, and approximately one-quarter to one-third of the questions assess content applied to a Task of Teaching of Science.</i>			

Each subject is broken into individual topics with videos on the material where the content is taught to the viewer. Each of the videos is structured in a clear and concise way that allows for them to be viewed in a small amount of time that does not detract from the teacher's day. This also includes practice problems and

Test Name	Physics		
Test Code	5266		
Time	2 hours 30 minutes		
Number of Questions	125 selected-response questions		
Format	The test consists of a variety of selected-response questions, where you select one or more answer choices and other types of questions. You can review the possible question types in Understanding Question Types.		
Test Delivery	Computer Delivered		
	Content Categories	Approximate Number of Questions	Approximate Percentage of Examination
	I. Nature and Impact of Science and Engineering	15	12%
	II. Principles and Models of Matter and Energy	19	15%
	III. Mechanics	44	35%
	IV. Electricity and Magnetism	26	21%
	V. Waves	21	17%
<i>Half or more of the questions integrate a Science and Engineering Practice, and approximately one-quarter to one-third of the questions assess content applied to a Task of Teaching of Science.</i>			

A simple Google search yields a myriad of free and low-cost study resources. Additionally, ETS offers a 90-day interactive practice test subscription available to users upon registering for a PRAXIS exam, and websites such as ExamEdge and Mometrix offer online practice tests and preparation study guides with detailed explanations.

Online Content-Specific Resources

Once prospective instructional add-on candidates have a chance to determine content strengths and weaknesses, various online resources may be utilized to augment the content background for exam preparation. A summary of several of these resources evaluated by the authors is presented as follows.

Khan Academy (<https://www.khanacademy.org>)

Khan Academy is an excellent resource for learning content and preparing for the PRAXIS II exam. Many school districts and some universities use Khan Academy as an academic resource to help their students learn and reinforce new material. This site can be used for both physics and chemistry. Materials covered on the site range from general to Advanced Placement (AP) level and also contain courses aligned with the Next Generation Science Standards (NGSS).

quizzes as forms of assessment to allow users to check for understanding during and at the conclusion of each section.

the Physics Classroom (<https://www.physicsclassroom.com>)

Physics Classroom is a website specifically designed to cover various topics taught in the typical physics classroom. For each topic, a section written in text-book-like format provides notes on the given topic. Also included are solved examples of problems related to each section's content and a number of accompanying physical property simulations coded to operate in web browsers and open on any device. These simulations include questions to assist in building conceptual understanding. Physics Classroom also has begun integrating its activities and simulation with the NGSS. Along with these simulations, is a section of concept builders that can be used as a form of assessment to check for understanding.

Other features are video tutorials, along with a complete archive of worksheets available for use. Users must pay to access the related answer keys if they wish to use the worksheet archive. The videos are linked through YouTube and, therefore, accessible with any internet connection.

video-tutor.net (organic chemistry tutor)

Similar to Khan Academy is **video-tutor.net**. The site links to a series of videos produced to address a wide variety of topics across both chemistry and physics. Each topic is explained in great detail and includes example problems that can be used to check for understanding. The site also contains videos that can be used as worksheets that include additional practice problems. The videos are linked to sites provided by other educational institutions (Self-Study Resources, n.d.).

Incentives

Incentives for earning instructional add-on certifications may be a strong motivational tool for educators. If a school district is willing and able to cover the cost of the add-on certificate, then there may be a stronger appeal for educators to pursue the option. Other incentives such as a one-time stipend also may be issued at the discretion of the school board in keeping with contractual obligations to further entice teachers to acquire instructional add-on certifications in high-need areas.

Career Changes

Another potential solution for the physical science teacher shortage that would require legislative action is to provide a pathway for degree-holding professionals in STEM-related careers to take the PRAXIS II exam in a science content area and earn a “provisional” teaching certificate. Following their first three years in the classroom, holders of a provisional teaching certificate would need to complete additional training in teaching and instruction from an accredited university or PDE-approved training program in order to obtain a permanent certification.

Although the idea of moving from a STEM profession to a classroom is non-traditional, it may offer a viable solution to the challenges created by the ongoing teacher shortage, and this concept should be examined at the state leadership level.

Conclusion

Given the current teacher shortage and associated costs of hiring new teachers, a logical, forward-thinking solution is to encourage in-service teachers to pursue instructional add-on certificates within necessary physical science certification areas as opposed to simply ignoring the problem passively. As shared within this article, a number of beneficial resources are available for preparation for PRAXIS II instructional add-on certificate examinations that can be carried over into the classroom once the certification has been obtained.

For further information, please contact Dr. Keeling at jkeeling@greenville.k12.pa.us. ■

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