# A PROFESSIONAL DEVELOPMENT PROGRAM FOR TEACHERS AT NAZARBAYEV INTELLECTUAL SCHOOLS

PASCO® scientific

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# Contents


| | |
|---|---|
| Introduction | 1 |
| Three Knowledge Domains | 2 |
| Essentials of Effective Professional Development | 3 |
| Initial Observations of the PASCO PD Program | 5 |
| Conclusion | 7 |
| References | 8 |

# Introduction

At its inception in 2012, Nazarbayev Intellectual Schools (NIS) in Kazakhstan established goals of modernizing its schools, integrating technology into teaching, and creating a world-class education system. This included transforming their science education program to include inquiry-based teaching to improve students understanding and interest in science. This model requires a significant shift from the direct instruction pedagogy of traditional teaching toward a pedagogy that supports and facilitates student-centered learning. Inquiry teaching calls for a skillset from teachers that includes applying effective classroom practices that support students' use of technology and guiding students through inquiry-based activities.

To meet the challenges teachers face in facilitating inquiry learning, NIS enlisted science education company PASCO Scientific to provide a comprehensive professional development program for their science teachers. The goal of the program was to help teachers build their knowledge and practices in subject content, technology, and pedagogy, all of which are areas of knowledge critical to science teaching. This paper describes the professional development offered to teachers and discusses the program's alignment to essential forms of effective professional development.

# Three Knowledge Domains

As teachers begin to implement inquiry-based learning activities, they shift from a conventional role of direct instruction to a role that facilitates learning. Teachers must be more than subject matter, technology, or teaching experts. Effective technology integration to teach science requires an understanding and negotiation of the relationships between content, technology, and pedagogy. The TPACK model, defined by Mishra and Koehler (2006), offers a framework for understanding this relationship.

This view of teacher knowledge defines three main knowledge domains—*Technological Knowledge*, *Pedagogical Knowledge*, and *Content Knowledge*—and recognizes that there is a complex interplay between these domains that influences a teacher's practice in the classroom. For example, teachers should be able to construct effective questioning sequences, intervene to address misconceptions, and help to develop students' understanding of content (Towns & Sweetland, 2008; Warner & Myers, 2008). Both content knowledge and pedagogical knowledge interplay with each other in this instance. If the teacher then incorporates technology, such as data logging in experiments, the teacher adds a third dimension to the interplay, technological knowledge, and forms a triangle of knowledge—technological, pedagogical, content knowledge—to facilitate a meaningful learningexperience.

Developing a cohesive triangle of knowledge can be daunting. To support teachers, PASCO devised a comprehensive professional development program that ensures teachers get training in all three of the TPACK domains, as well as training that addresses the complexity of the interconnections of these domains. In addition to focusing on a balance between these domains, the program aligns to selected best practices or enduring principles of effective professional development.

# Essentials of Effective Professional Development

Providing access to teacher professional development alone does not ensure effectiveness. Effective professional development programs follow best practices to ensure success. Although there are others, 3 principles of professional development have repeatedly shown a positive impact on teacher performance and student learning—*duration*, *active learning*, and *coherence in and emphasis on content-specific contexts* (Gulamhussein, 2013).

### *Duration*

In an analysis of factors that make professional development effective, two aspects of duration were considered important: time span and contact hours. Sustained professional development over a lengthy time span involving a significant investment in contact hours is likely to increase the effectiveness of professional development. Some studies suggest that 50-80 hours are needed to affect teacher practices in a way that improves student learning (Gulamhussein, 2013). With an increase in contact hours, teachers have adequate time to observe others, discuss and practice new content and pedagogy, practice new technologies, and be engaged in other activities that make their professional development an integral part of their work.

Additionally, there is a positive correlation between these attributes and other essential features of professional development, such as active learning and coherence (Garet, Porter, Desimone, Birman, & Yoon, 2001).

### *Active Learning*

Watching videos as a part of professional development is an example of passive learning. To make sense of new knowledge and teaching practices, teachers need to participate actively. Active participation can include role-playing, open-ended discussion, and observing experts model new practices (Gulamhussein, 2013). Some successful programs that improved teachers' use of inquiry learning engaged them in the following: using technologies like a student would, experiencing models of teaching practices by mentor teachers, promoting the exchange of and customization of lesson plans, and collaboratively developing solutions to address implementation challenges or student performance that fell short of expectations (Gerard, Varma, Corliss, & Linn, 2011).

### *Coherence and Emphasis on Content-Specific Contexts*

Teachers can best understand and apply new practices when content is presented using the subject-matter they teach (Gulamhussein, 2013). There is a strong correlation between an emphasis on content and a positive effect on teachers' enhanced knowledge and skills (Garet, Porter, Desimone, Birman, & Yoon, 2001). Coherence—an alignment between the professional development activities and standards and assessments teachers are accountable to—was another important factor in positively influencing teachers' knowledge, skills and changes in teaching practices (Garet, Porter, Desimone, Birman, & Yoon, 2001; Birman, Desimone, Porter, & Garet, 2000).

PASCO Professional Development Specialists with backgrounds in teaching, adult learning, science, and technology developed a custom program for NIS teachers aligning it to the professional development principles outlined above. Also included in the program was an emphasis on the TPACK knowledge domains.

# Initial Observations of the PASCO PD Program

Two cohorts of NIS science teachers from across Kazakhstan received training at PASCO headquarters, 15 teachers in 2012 and 14 teachers in 2013. Each cohort participated in a 2-week long training—5 days of training, 2 days off, and 5 more days of training. For the most part, teachers taught in 1 of 3 subject areas: biology, chemistry or physics. All teachers taught at the high school level. The goals for the PD focused on deepening teachers' technological (probeware-based), pedagogical, and content knowledge, providing coherence with their science curricula, and providing opportunities for active learning.

### *Duration*

NIS teachers received 10 full days of training over the course of 2 weeks, which exceeded the minimum recommendations by research to affect teacher practices in the classroom to support student learning improvements (Gulamhussein, 2013). In that timeframe teachers made good progress on their technological, pedagogical, and content knowledge. The first cohort of NIS teachers also participated in an online follow up to address any issues in using the technology to teach science and to provide support in implementing additional activities with their students.

### *Technology, Pedagogy and Content*

Informal observations of the groups revealed 3 important changes in the teachers over the course of the 2-week period. As most teachers were unfamiliar with probeware-based technology, learning the technology became a priority for them. They quickly learned to use the data collection device to conduct both simple and complex science investigations with confidence.

Since these teachers held degrees in their respective sciences and have been teaching science, some for many years, expectations of their content knowledge was high. Indeed, they did know their science, but occasionally misconceptions about a concept surfaced. In those instances use of probeware in the investigations helped the teachers to change their understandings through real time data collection with a visual representation of the phenomenon.

Prior to the workshop, the teachers used direct instruction as their primary pedagogical approach to teaching. The goal of the workshop was to have teachers leave with the skillset and the confidence to begin teaching science from a guided inquiry approach. Over the course of the 2 weeks, through discussions, modelling, and various activities, teachers demonstrated a shift in their pedagogical approach. In the workshop teachers learned about the concept of inquiry-based teaching, practiced a variety of inquiry-based approaches such as think-pair-share (Lyman, 1981) and predict-observe-explain (White & Gunstone, 1992), and participated in a series of role playing events requiring them to practice the art of inquiry-based teaching. Teachers left the training confident in their ability to begin teaching their science classes with a more guided inquiry approach.

### *Active Learning*

From day one in the multi-day workshop, NIS teachers were actively engaged in learning technology, content, and pedagogy. Although there were a handful of lab demonstrations, most of the lab activities were conducted by the teachers themselves, either individually or in groups. The teachers were required to prepare lessons and teach other teachers who were role-playing as students, thus putting into practice techniques for inquiry-based teaching. The repetition and feedback to the teachers helped them build their skills and confidence to return to the classroom to incorporate the first stages of inquiry teaching.

### *Coherence and Emphasis on Content-Specific Contexts*

In the design of the PASCO PD program teachers received some cross-subject training on shared technology and pedagogy topics, but a significant portion of the training was customized to each teacher's subject area, ensuring coherence between the science lab activities and subject-specific requirements. Also, PASCO trainers selected or developed lab activities that aligned to the curricula and standards followed by the NIS teachers. Fulfilment of both of these requirements ensured that teachers had a meaningful and useful learning experience.

# Conclusion

NIS selected PASCO to help realize their goals to modernize schools, integrate technology in the science classroom, support teachers in their shift to inquiry-based teaching, and in the long run, help to transform science education in Kazakhstan. PASCO designed and built a professional development program that leveraged best practices such as duration, active learning, and content-specific contexts in the training and helped teachers build their knowledge in subject content, technology, and pedagogy. As NIS teachers integrate and apply the knowledge acquired from their training, they will continue to evolve and develop their skills in teaching science with technology using an inquiry-based pedagogical approach. An investigation into teachers' content, pedagogical and technological knowledge, along with their ultimate effect on student learning would be an important and valuable future research direction.

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