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1. SAUDI SCIENCE TEACHER PROFESSIONAL DEVELOPMENT

Trends, Practices and Future Directions

ABSTRACT

Professional development is one significant mechanism for maintaining a high standard in science teaching. This chapter is intended to provide guidance that stems from best practice, as highlighted in the relevant literature and analysis of the state of science education in the country. The chapter consists of three main sections: the first section reviews what has been published over the past decade, which provides a base of knowledge about the characteristics of effective professional development. The second section depicts the status of professional development in Saudi Arabia, and highlights where we have yet to improve. It draws on the available data and efforts surrounding professional development. The third section attempts to identify the various challenges ahead regarding professional development. Based on these three sections, we propose recommendations for the advancement of science teacher professional development in Saudi Arabia.

INTRODUCTION

The Kingdom of Saudi Arabia is investing in a significant opportunity to gain improvements in education. This includes allocated governmental funding for the new science and mathematics curriculum, as well as King Abdullah's project for public school education (Tatweer Project). Science education in Saudi Arabia is receiving more attention than it has ever received before. The government contracted a national company (partnered with an international company) to provide new instructional materials supported by professional development programs for both science supervisors and teachers.

These efforts, essential as they are, need to be accompanied by a more effective and systematic approach to supporting, developing, and mobilising science teachers who will teach in and lead schools. The reform initiatives in science education are causing a shift from conventional teaching styles to more progressive, inquiry-oriented methods. This means that teachers need to be supported regarding how to approach such novel teaching.

N. Mansour & S. Al-Shamrani (Eds.), Science Education in the Arab Gulf States, 3–21.

Professional development is one significant mechanism for maintaining a high standard in science teaching. The most important reason for professional development as identified by the American Association for the Advancement of Science (AAAS, 1998) is to help teachers to recognize the special expertise related to their work. Second, Professional Development is essential for teachers to master the knowledge and skills needed as pre-service education is neither long enough nor intense enough. The third reason is to help teachers grow and develop and, finally, to improve teaching quality.

In a centralized education system as in Saudi Arabia, educational authorities are responsible for setting policies and making decisions on the kinds of professional development that will be supported and implemented. In this chapter we intend to provide guidance which stems from best practice, as highlighted in the relevant literature and analysis of the status of science education in the country.

The following pages include three main sections. The first section provides a review of the existing research on effective characteristics of professional development. The second section depicts the state of professional development in Saudi Arabia, through snapshots of how professional development is being designed. The chapter ends with a third section in which we propose future directions for advancing science teachers' professional development in Saudi Arabia. Not least, this chapter is a major first step toward developing a comprehensive set of policies and practices that help to better organize professional development. Our ongoing research, informed by the wider literature on professional development, attempts to develop a framework of professional development that can enrich the practices of science teacher development. Our concern as researchers is to develop a greater understanding of what makes professional development effective.

SIGNIFICANCE OF PROFESSIONAL DEVELOPMENT TO SAUDI CURRICULUM IMPLEMENTATION

What is the best way to reform science education in Saudi Arabia?. Currently, The country is running a new science education reform, In 2009 a new Mathematics and Science Curriculum was launched; an adapted series of science textbooks produced by American publishing company McGraw-Hill was translated and modified to be adopted for all school levels. The new science curriculum emphasizes current teaching and learning trends and promises to adopt a learner-centred approach with inquiry-based instruction (Obeikan, for Research and Development, 2010). But this will only happen if teachers' classroom practices reflect high standards. It appears that teachers do not implement appropriate teaching practices (Alrwathi Almazroa, Alahmed, Scantbly, & Alshaya, 2014). Education reforms will not succeed without teachers who are immersed in the subject they teach and well equipped to implement appropriate teaching practices.

Professional development of teachers plays a key role in the new curriculum implementation and is widely believed to be required in order to support

implementation (Richard & Neil, 2011; Spillane & Thompson, 1997). Reforming science education requires much more intensive professional learning than has been available until now. There is a concern in curriculum implementation that teachers will continue with existing traditional teaching practices, with a little tinkering to show that they have modified their teaching towards the specified way (De Beer, 2008). Therefore, Atweh, Bernardo and Balagtas (2008) consider teachers as the principal mediators of curriculum implementation and view professional development as an integral component if curriculum reform is to reach the classroom. We view professional development as a crucial element of the nation's efforts to improve education. Blank and Alas's (2009) meta-analysis study provided evidence of the effects of science and mathematics teachers' professional development on improving student learning. By measuring and summarizing consistent, systematic findings across multiple studies, a positive relationship between student outcomes and key characteristics of the design of professional development programmes was identified.

In Saudi Arabia, professional development has only recently been considered a national priority and a main research priority in the field of science education (Alshamrani, 2012; Obeikan for Research and Development, 2010). So far, much of the professional development that is offered to teachers simply does not meet the demands of the new curriculum (Almazroa, Aloraini, & Alshaye, 2014). However, as Richard Elmore stated in American Federation Of Teachers (AFT), "Unless you have a theory about how to support instructional practice, you don't have a prayer" (AFT, 2008, p. 1).The focus should be on formulating and implementing professional development that makes realizing the reform possible. Since professional development is an essential element of comprehensive reform, it has to be carefully crafted and well designed, otherwise the dream will not be realized. An effective professional development programs requires radical changes in practice. Furthermore, if it is to be understood as learning activities rather than training activities, as Mansour, El-Deghaidy, Aldahmash and Alshamrani (2012) note, it should have a guiding framework that frames all the activities, so professional development leaders can design meaningful learning experiences for all teachers.

Therefore, the Ministry of Education needs to bolster teachers' knowledge and skills and ensure that professional learning is well planned and organized, as improving professional learning for educators is a crucial step in transforming schools. In fact, science teacher professional development all around the world has received special attention among policy-makers (National Research Council, 2009). Today, professional development is a major focus of the reform initiative and has become a necessary expectation in schools. The need for high quality professional development is urgent in light of the many new tenets on which the new curriculum is based. Therefore, understanding the characteristics of effective professional development is an important starting point to provide support for policy-makers and educators. Research is needed to examine what kinds of professional development provide support for the implementation of the new curriculum.

CHARACTERISTICS OF EFFECTIVE PROFESSIONAL DEVELOPMENT FOR SCIENCE TEACHERS

The concept of professional development has changed from a fairly narrow view which regards professional development as a special event that is restricted to a few days with top-down models, to a wider concept defined as "processes and activities designed to enhance the professional knowledge, skills, and attitudes of educators so that they might, in turn, improve the learning of students" (Guskey, 2000, p. 16). Beliefs about professional development have changed from in-service programmes, which aim to use outside expertise to increase teachers' knowledge, to a wider spectrum which includes not only teachers but also the organization to which the teacher belongs (Loucks-Horsley, Hewson, Love & Stiles, 1998). Reform models engage teachers in authentic activities within learning communities, connecting professional development to classroom work, and emphasizing inquiry-based instructions (Butler, Lauscher, Jarvis-Selinger & Bechingham, 2004).

Central to efforts to improve the quality of professional development is the provision of research-based evidence of effective characteristics. Research over the last few years has provided a base of knowledge about important qualities pertaining to the design and enactment of professional development. During the last decade there has been an increasing focus on what makes professional development effective. This section summarizes current research, which has been discussed in the domain of general education and more specifically in science education, by experts in the field as well as agencies in education.

Significant contributions are represented in agencies' efforts to provide guidance in developing effective professional development. In the US the National Staff Development Council (NSDC, 2001) outlines standards for staff development to improve all students' learning; these standards are listed in Table 1. Also, to supply evidence on the impact of high-quality teacher professional development, the American Federation of Teachers (AFT, 2011) published principles for professional development, which were derived from teachers' views (see Table 1).

What does research say that works and what needs to be done to develop the best learning opportunities for science teachers? Darling-Hammond, a well-recognized expert in the field, identified essential elements to professional learning that need to be included in pre-service and in-service education (1998, p. 2, see Table 2). Birman, Desimone, Porter and Garet's (2000) research-based study marked an important advance within the field because it relied on a survey of 1000 teachers who participated in a professional development programme, and on case studies, and gave empirical evidence on the relative value of professional development features. They identified three structural features that set the context for professional development – form, duration, and participation – and the core features necessary for the success of those structural features – content focus, active learning, and coherence (see Table 2). Many of the features of professional development which

Table 1. Professional development characteristics as viewed by educational agencies

NSDC (2001)	*AFT (2011)*
Staff development that improves the learning of all students should have the following features: • learning communities, • leadership development, • required resources, • data driven, • uses multiple sources for evaluation, • research-based, • appropriate strategies for the intended goals, • understand equity, • quality teaching, • family involvement.	Professional development should: • deepen and broaden knowledge of content, • provide a strong foundation in the pedagogy of particular disciplines, • provide knowledge about teaching and learning processes, • reflect the best available research, • be aligned with the standards and curriculum that teachers' use, • contribute to a measurable improvement in student achievement, • be intellectually engaging, • provide sufficient time, support, and resources, • be designed by teachers in collaboration with experts in the field, • take a variety of forms, including some we have not typically considered, • be job-embedded and site-specific.

Table 2. Professional development characteristics as viewed by experts

Darling-Hammond (1998)	*Birman, Desimone, Porter and Garet (2000)*
• Professional development avoids generalities and abstractions and deals with everyday teaching and learning practices such as lesson planning and student evaluation. • It is built around real cases and questions. • It builds colleagueship through encouraging professional discourse which leads to analysis and communication about practices and values.	• Reform orientation with reform-oriented activities. • Duration in terms of both time and span and total contact hours. • Collective participation of teachers from the same school. They also identified the core features necessary for the success of those structural features: • *Content* refers to enhancing teachers' discipline knowledge, • *Active learning* encourages teachers to become more engaged in discussion, planning, and practice, • *Coherence* refers to the extent to which professional development experience is part of the integrated programme of teacher learning.

they found to be significant predictors of effectiveness had been already identified in the literature.

As a field, science education has a set of recommendations for fostering professional growth. The National Research Council published a set of professional development standards in 1996 entitled the *National Science Education Standards* (NSES). These include recommendations for teachers of science to learn science content through inquiry, to integrate knowledge of science, learning, and pedagogy, to build understanding as a lifelong learner, and for professional development opportunities to be coherent and integrated (NRC, 1996; see Table 3). Loucks-Horsley et al. (1998, p. 37) described a common vision of effective professional development in science and mathematics. This common vision identifies the seven principles that are listed in Table 3.

Table 3. Professional development characteristics as viewed in science education

NRC (1996)	*Loucks-Horsley et al. (1998)*
• Learn science content through inquiry. • Integrate knowledge of science, learning, and pedagogy. • Build understanding as a lifelong learner. • Professional development opportunities that are coherent and integrated.	• A well-defined image of effective classroom learning and teaching. • Opportunities for teachers to build their knowledge and skills. • Use or model with teachers the strategies they will use with their students. • Build a learning community. • Support teachers to serve in leadership roles. • Provide links to other parts of the education system. • Assess themselves and make improvements to ensure positive impact on teacher effectiveness.

At the local level, reaching a consensus regarding characteristics of effective Saudi professional development is an important starting point to leverage support for policy makers and educators. Almazroa (2013) attempted to provide a conceptual framework for professional development and produced a list of characteristics for professional development that are suitable for the Saudi educational system, by relying not only on the literature, but surveying a sample of Saudi science teachers, five key dimensions were derived for professional development. Table 4 provides an overview of the vision for professional development that includes certain elements of each dimension

Table 4. Effective characteristics of Saudi professional development for science teachers

Professional Development Dimensions	*Effective characteristics*
Goals	1. Share a common vision of teaching and learning. 2. Promote collegiality and collaboration to create learning community for science teachers. 3. Build leadership capacity. 4. Increase teachers' creativity and innovation. 5. Teaching ethics.
Content	6. Deepen teachers' content knowledge. 7. Learn content knowledge through investigation and inquiry. 8. Provide a strong foundation in the pedagogy of the disciplines. 9. Professional development should provide knowledge about the teaching and learning processes. 10. Based on teachers' needs.
Support	11. Must be long-term coherent plans. 12. Provide incentive to ensure motivation and encourage teachers' participation. 13. Provide highly qualified training team. 14. Provide support and mechanisms to enable teachers to master new content and pedagogy and to integrate these into their practice. 15. Require resources to support learning.
Approaches	16. Should take a variety of forms and include a follow-up with teachers. 17. Teachers, who are the practitioners, should be centrally involved in formulating professional development plans in cooperation with experts in the field. 18. Include active methods of teacher learning. 19. Use various technological innovations to learn content and pedagogy.
Evaluation	20. Must be reviewed and assessed to constantly improve the impact of these activities.

A ANALYSIS OF CURRENT PREFESSIONAL DEVELOPMENT IN RELATION TO RECENT TRENDS

Although formal education in Saudi Arabia was founded in the 1930s, attention to teacher professional development programmes was initiated in 1975 under the *General Administration of Teacher Preparation Programs*. In 1981, it came under the *General Administration of the Educational Guidance and Training*. It was not until 1998 that an independent administration for teacher training was launched called the *General Administration for Educational Training and Scholarships*, which was responsible for two types of professional development programmes: teacher training and internal and external scholarships for teachers (Ministry of Education, 2013). Currently, a centre for training and scholarship has been established in each of the 45 educational departments across the entire Kingdom; these centres provide training programmes for all teachers.

Moreover, science and mathematics teachers receive a secondary professional development programme as part of the Project of Mathematics and Natural Sciences (PMNS), the new reform in science and mathematics education, which was launched in 2009. Programmes introduced through PMNS are related to science and mathematics teaching than those programmes introduced by the centres. For example, the centres design and provide professional development programmes to suit any teachers, whereas PMNS professional development is specifically tailored towards science or mathematics teachers. PMNS trains science supervisors to prepare them to train science teachers; however, the centres provide their programmes independently according to a general plan by the general administration.

Although PMNS uses the term 'professional development programmes', it utilizes training workshops as the most common source for science teacher professional development. In fact, the term 'training' is the most prevalent term mentioned when it comes to educational research in Saudi Arabia. Predominantly, the researchers investigate either the impact of a training programme with regard to some independent variables or the training needs for science teachers (Abulhamail, 1999; Aldalan, 2004; Alfohaid, 1999; Flemban, 2003; Rafa, 1993). However, the *Excellence Research Center of Science and Mathematics Education* (ECSME) at King Saud University conducted a pilot study to identify the research priorities in science education in Saudi Arabia; the study found that research in professional development programmes was the highest research priority in the context of Saudi Arabia (ECSME, 2009). This study was followed by Alshamrani (2012), who aimed to identify the same goal using the Delphi method. Unsurprisingly, this study also found that research in professional development was the first research priority in science education in Saudi Arabia. In 2010, as part of the ECSME's goals, a research group was initiated to study science and mathematics teacher professional development, and has been conducting important work which reflects the status of science teacher professional development, in addition to what has been carried out by other researchers such as Alshaye (2013).

In this chapter, we attempt to shed some light on the extent to which Saudi science teachers receive the kinds of professional development that the research recommends. Readers should be reminded that researchers for this paper found limited official documentations about professional development. Thus, this section relays heavily on recent research on science teacher professional development in Saudi Arabia. In this section, we identify common findings across studies on the status of professional development in comparison to Saudi effective professional development characteristics listed by Almazroa (2013) as follow:

1. Goals of Professional Development Programmes

As a central education system in Saudi Arabia, the goals of PD programmes established by the Ministry of education through identifying the needed skills and competences of teachers (Sabah, Fayez, Alshamrani, & Mansour, 2013). Mansour et al. (2012) found a mismatch between the perceptions of science teachers and their supervisors regarding their PD needs; they argued that other authorities in the Ministry of Education may have different priorities. Sabah et al. (2013) indicated that the PD programme providers do not participate in defining PD they are providing. Moreover, Mansour, El-Deghaidy, Alshamrani, and Aldahmash (2014) found that the teachers do not also participate in articulating the goals of their received programs. They also indicated that a single provided programme expected to fit all the teachers regardless of their teaching subject, existing knowledge, needs, and school contexts. The lack of the voice of science teachers, supervisors, PD providers, and other related people can minimize the achieved expected outcomes of such these PD programs.

The analysis of the listed programs and guidebooks for training programs in some educational districts in Saudi Arabia indicated that there is a lack of guiding goals for these programs. The lack of these shared goals among the educational district can be attributed to the way of formulating the list of the provided programs. As indicated by the providers of PD programs, forming a list of training programmes starts through prioritizing the needs of science teachers by the Ministry of Education (Sabah et al., 2013). Although we did not find an evidence of an existing list of goals leading PD for the teachers, it might be exist in some ways; yet, what is apparent for us is the lack of enhancement of shared goals on formulating a coherent PD programs for the teachers in the educational districts. However, In King Abdullah's project for public school education (Tatweer Project) which is supposed to contribute to science teacher development, a set of goals are provided for PD; the goals related to science teachers are: improving general education outcomes through developing basic teaching skills, improving learning capacity for both teachers and supervisors, and improving teachers' leaderships of their classrooms (Tatweer Project, 2014). However, no evidence has been provided yet to clarify who to reflect these goals on teacher PD programs.

2. *Content of Professional Development Programmes*

Alshamrani et al. (2012), Mansour et al. (2013), Alshaye (2013) and EL-Deghaidy et al. (2014) used the voices of science teachers, supervisors and PD programme providers to reveal the content covered in the professional development programmes. These studies concluded that programmes focused on both subject knowledge and pedagogy. However, they reported that pedagogy receives more attention in comparison to subject knowledge. EL-Deghaidy et al. (2014) interviewed science teachers to identify their PD needs and subsequently classified them into four main themes: pedagogical, scientific, Information, Communication Technology (ICT), and professional skills. Table 5 shows these themes and their sub-themes.

Table 5. Professional development needs reported by science teachers (EL-Deghaidy et al., 2014)

Main categories	*Sub-themes*
Pedagogical knowledge	Deepening pedagogical content knowledge
	Responsiveness to the new science curricula reforms
	Classroom management
	Assessment
	Accommodating students' individual differences
Content knowledge	Deepening subject content knowledge
	Practical skills
	Cultural issues related to science education
ICT	Technological pedagogical content knowledge (TPCK)
Professional skills	Self-development and learning how to learn
	Teacher as a researcher
	Leadership

However, this list of themes do not fit with what are actually provided; PD programme providers mentioned that they delivered content such as teaching strategies, classroom management, project based learning, differentiated learning, active learning, inquiry, and constructivism (Sabah et al., 2014). The guidebook for training programmes included a special list for the provided programmes for science and mathematics teachers; this list encompasses: the basic kit, differentiated instruction, active learning, conceptual understanding, planning for understanding (Tabouk Educational Administration, 2014). This list can be found in all educational districts since they are provided by the Ministry of Education. Moreover, science teachers in all districts can receive some general programmes such as assessment and educational technology; however, the main distinction between the list of actual

programmes and the reported needs for science teachers are content knowledge and professional skills.

3. Supports for Professional Development Programmes

In an evaluation study provided to the Ministry of Education, it was found that the organizational support for PD was low as viewed by 1999 science and mathematics teachers (Almazroa, Aloraini, & Alshaye, 2015). Alshamrani et al. (2012) identified some obstacles related to the supports from either ministry or administration levels that Saudi science teachers face when participating in professional development programmes; the most important included a heavy teaching workload, inappropriate timing of the professional development programme, lack of advertising, the restricted number of available professional development programmes, and the limited incentives to encourage participation in professional development programmes. In another study (EL-Deghaidy et al., 2014), teachers reported factors that may persuade them to participate more in professional development programmes, including receiving financial recognition, attendance certificates, reducing teachers' workload, and consideration of teachers' opinions. They also mentioned some factors related to the programmes such location, timing and duration, and utilizing ICT.

4. Approaches for Professional Development Programmes

Almazroa, Aloraini, and Alshaye (2015) surveyed 1999 science and mathematics teachers to evaluate PD programs they are receiving, findings revealed that the most prevalent PD methods were workshops (29.3%), supervisor guidelines (21.3%), teachers' classroom exchange visits (15.6%) and model lesson observations (13.4%), it was found that other methods were not popular and were practiced rarely, including discussion groups (8.6%), meetings and symposia (4.2%), online training (4%) and participation in research (2%). The studies by Alshamrani, Aldahmash, Alqudah and Alroshood (2012) and Alshaye (2013) aimed to identify the status of science teacher professional development programmes in Saudi Arabia. Alshamrani et al. (2012) focused on science teacher programmes from science teachers' and supervisors' perspectives whereas Alshaye focused on science and mathematics teachers from the providers' perspectives. The results of the two studies have many variations and junctions; however, they led to one conclusion: the professional development of science teachers is not benefitting from important sources such as communities of practice, universities, and associations. Science teachers are limited to their official interaction with their supervisors, official training programmes and workshops, official observation exchanges with peers, and personal interest in reading. Sabah et al. (2014) found an absence of school enacted PD such as peer coaching, critical friendships, mentoring, action research, and the community of practice model; and out of school learning such as joining professional development networks, school-university partnerships, conferences. In EL-Deghaidy et al. (2014) study, science

teachers talked about official training programmes when it comes to professional development programmes. Howell and Stubbs (1996) asserted that professional development programmes should go beyond the official initiatives. Furthermore, the National Science Education Standards in the United States suggest some techniques for life-long learning:

> Teachers of science develop the skills to analyze their learning needs and styles through self-reflection and active solicitation of feedback from others. They must have the skills to use tools and techniques for self-assessment (such as journal writing, study groups, and portfolios) and collaborative reflection strategies (such as peer coaching and mentoring, and peer consulting). (NRC, 1996, p. 69)

Darling-Hammond Wei, Andree, Richardson, and Orphanos (2009) also stated the following: "Beyond the structure of the work day that accommodates daily professional collaboration, many high-achieving nations dedicate significant resources to professional development, often drawing on expertise beyond the school" (p. 17).

Quint (2011) mentioned that the 'one shot' workshop approach should not be the only source for teacher professional development programmes; she stated that other sources supporting continuous development should be utilized, such as intensive summer institutes and follow-up group sessions. The lack of such important activities for Saudi science teachers can be attributed to the educational policy which does not differentiate between highly efficient teachers and those of a lesser ability, and therefore teachers have a low level of responsibility for their professional development and wait for what is officially provided.

PD programme providers asserted that they directly receive the programmes from the Ministry of Eduation then, finally, they deliver them to the teachers (Sabah et al., 2014). This 'top-down' approach does not encourage teachers to be involved in the processes of designing their professional development programmes. The National Science Education Standards (NRC, 1996) stated that science teachers should be able to set their goals and take responsibility for their own professional development. Consequently, taking control can lead to ownership and self-empowerment for the teacher and ultimately bring about lifelong professional development.

5. Evaluation for Professional Development Programmes

Guskey (2002) introduced his model in evaluating PD programs; this model consist of five levels which are participants' reaction, participants' learning, organization support and change, participants' use of new knowledge and skills, and students' learning outcomes. This model is considered as comprehensive and coherent (Bolam & McMahon, 2004) Hoverer, PD programmes for science teachers in Saudi Arabia, seems not having a systematic, comprehensive, and coherent evaluation model. Sabah, Fayez, Alshamrani, and Mansour (2014) interviewed the providers of these

programs and came up with that the providers reflect simple and general processes for evaluating PD programmes. The providers vary on their response when they asked about programme evaluation; they mentioned different approaches, and all of them indicated approaches related to three levels or less of Gyskey model. They emphasized some levels of Guskey model such as evaluating participants' reactions and participants' use of new knowledge. However, few of them mentioned participant learning, and none of them mentioned evaluating organization support and change. This result implies that there is a lack of comprehensive and systematic approach of evaluating science teacher PD programs. It seems that the providers used some different approach depends on their views of how can these programs be evaluated. In another study (Almazroa, Alorainin, & Alshaye, 2015) to probe teachers' opinions about the role of evaluation in PD. Teachers believe that PD activities lack follow-up and evaluation activities, which means PD programs and activities need to be rigorously evaluated to provide data for improvement

LESSONS LEARNED FOR SCIENCE TEACHER PROFESSIONAL DEVELOPMENT IN THE SAUDI EDUCATIONAL SYSTEM

We suggest here that a critical analysis of the current status of Saudi professional development in light of ideal professional development provides a sound platform for further development and implementation. The recommendations presented below are derived from the above discussion.

First Recommendation: Forming a Community of Practice

We recommend forming and supporting a community of practice among science teachers and building their leadership capacity. Teachers could communicate with other teachers about their experiences and even discuss with teachers from other schools. This could be done through forming a cooperative learning group at the school level, at the supervision office level, or at the educational district level. The promotion of collegiality and collaborative learning results in improvement on an individual level, as well as in the policies and practices of the community. The National Science Education Standards (NRC, 1996) recommend that the following changes should be emphasized: 1) from individual learning to collegial and cooperative learning, 2) from the teacher as an individual based in a classroom to the teacher as a member of a collegial professional community, and 3) from the teacher as follower to the teacher as leader. A learning community is a feature requested by the National Staff Development Council (NSCD) professional development standards (NSCD, 2001), and the National Council for Accreditation of Teacher Education (NCATE) professional development standards (NCATE, 2001). In fact, educational reform necessitates the formation of learning communities because cooperative activities play a major role in successful teaching (Butler et al., 2004).

Encouraging continuous professional communication among teachers could be obtained through building leadership capacity, so that a teacher becomes a member of a collegial professional community, and preparing teachers to be skilful school leaders who guide continuous instructional improvement. In their study on Saudi science teachers' views and experiences about continuing professional development, Qablan, Mansour, Alshamrani, Sabbah and Aldahmash (in press) recommend assigning science teacher leaders in each school who should be in direct contact with other teachers, to assist them in learning and applying new knowledge and skills and thus improve the academic performance of the students. Another option is to establish societies and associations which could lead to informal dialogue and formal meetings, thus creating a sense of community among science teachers as well as catering for their practical and emotional needs.

Second Recommendation: Learning v. Training

Training is the most common form of professional development and the one with which educators have the most experience. Although it is understandable to use a one-shot session and select a particular topic in which training and an initial level of understanding is necessary, 'one size fits all' should not be the dominant method of professional development.

Training is only one of the many ways to provide professional development. The National Science Education Standards recommend a change in emphasis from courses and workshops to a variety of professional development activities (NRC, 1996). Professional development for teachers should include active methods of teacher learning which mirror the methods to be used with students; teachers are adult learners and need different methods to suit their individual differences (AFT,2008). Professional development should be understood as learning activities and not as training activities, according to Mansour et al. (2012). A variety of forms and follow-ups with teachers could be utilized, such as discussions with colleagues, study groups, teacher networks, coaching, mentoring, and professional networks (NSDC, 2001). In addition, in their book entitled *Designing Professional Development for Teachers in Science and Mathematics,* Loucks-Horsley et al. (1998) list strategies for designing learning activities that best suit the specific goals and context as methods for professional development. These diverse strategies could be used as extended support for teachers to offer them a chance to ask questions and interact with professional developers and other colleagues and receive feedback (Garet, Porter, Desimone, Birman & Yoon, 2001).

Third Recommendation: Reflection Enhancement through Coherent Long-Term Plans

Changes in teachers' beliefs and practices do not happen in one event; it takes time and several experiences to reach attained goals (Adey, Hewitt, Hewitt & Landau,

2004; Darling-Hammond & Youngs, 2002; Garet et al., 2001; Joyce & Showers, 1988). Most professional development comes in the form of workshops focusing on discrete topics, where connection to the classroom is left to teachers' efforts. Such discrete workshops do not allow teachers the time to try out ideas in the classroom and reflect on the results.

Reflection helps teachers to personalize activities and enact new materials in the classroom. Educators point to the value of reflecting on teacher learning, as experience alone is not guaranteed to promote learning (Loughran, 2002). The effectiveness of professional development programmes increase when there is a continuous, coherent plan that provides teachers with opportunities for discussions and reflections. Meta-analysis studies have found a positive impact of time and the number of professional development programmes for science and mathematics on student learning (Blank & Alas, 2009).In fact, Science Education Standards (NRC, 1996) and NSDC Professional Development Standards (NSDC, 2001) include long-term, coherent professional development. We need to make sure that professional learning is organized so that it can be sustained throughout the school year. We recommend that reflection is to be a goal of professional development, and a structure should be provided to promote reflection tohelp teachers become reflective practitioners. Allowing time and instructions for teachers to reflect assists teachers by helping them feel comfortable enacting the reform-based curriculum in their classrooms.

Fourth Recommendation: Understanding Content through Inquiry

Supporting teachers in increasing their own content knowledge is an important feature of professional development, because teachers can be at a great disadvantage if they do not follow advancements and changes in science. One important call within the science teaching community is for professional development to focus on content (Garet et al., 2001). Furthermore, deepening teachers' content knowledge is one of the professional development principles, according to the American Federation of Teachers (AFT, 2008). Also, it is one of the professional development standards for staff development (NSDC, 2001).

Content knowledge is important because teachers cannot teach what they do not know; those who do not know the content well cannot teach it well. If teachers do not develop adequate content knowledge, they are likely to be uncomfortable with the material and consequently they may experience difficulties when teaching.

Teachers should learn content through inquiry, because part of knowing how to teach science is knowing what it means to do science (Garet et al., 2001). Varied approaches could be utilized, for example, teachers completing inquiry activities during workshops, forming groups within each school to investigate socio-scientific issues, and establishing partnerships with hospitals and other sectors to encourage teachers to participate in issues and problems related to science, technology and society. The National Research Council published a set of professional development

standards in 1996, which include recommendations for science teachers to learn science content through inquiry (NRC, 1996). The professional development standards encompass the change in emphasis from learning science through lectures and reading to learning science through investigation and inquiry.

Fifth Recommendation: Organizational Support for Teachers

Providing support for science teachers is critical in order to implement what they are learning. Professional development needs strong, highly visible organizational support and could be implemented in many ways. Sufficient time, resources, and professional assistance should be provided to support teachers integrating new knowledge and skills into everyday practices.

Organizational support can be a key to the success of any professional development effort; for example, when teachers participate in a professional development programme on educational technology, and gain a thorough understanding and organize a variety of classroom activities based on computer simulation activities. Following their training, they try to implement these activities in schools where there is a lack of computers and the supervisor's focus is on students finishing the assigned book chapter. Another example is when teachers participate in a professional development programme on formative assessment, where teachers have to implement their training in schools where students are only graded on a summative assessment. Organizational policies and practices such as these can hinder the most valiant efforts, even when the individual aspects of professional development are done correctly. The lack of positive results is not due to inadequate professional learning; rather, it is due to organizational support that is incompatible with implementation efforts.

Sparks and Hirsh (1997) point to the importance of addressing individual learning and organizational change simultaneously to support one another, because gains made in one area could be affected by barriers in the other. Guskey (2000), in his professional development evaluation model, turns his attention to the organizational characteristics and attributes necessary for success in evaluating professional development programmes and activities. He believes that policies and organizational factors at the school, district, and national levels affect professional development content, processes, and outcomes.

CONCLUSION

In this chapter we have drawn on literature and our own experience as researchers and practitioners to show how teacher development can be designed effectively. The analysis of Saudi professional development that we have offered in this chapter shows the complexity of the task for those who have a role to play in making provision for science teacher professional development.

This chapter is concerned with improving professional development for science teachers in Saudi Arabia by providing a base of knowledge about the characteristics of effective teacher professional development programmes in science, so that programme designs are based on evidence of what successfully improves teachers' knowledge and skills, which will in turn advance the quality of teaching in science.

Moreover, this chapter identifies what research says works and what should happen to develop the best learning opportunities for science teachers. Not least, this chapter is a major first step toward developing a comprehensive set of policies and practices that will help better organize professional development for science teachers in Saudi Arabia.

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