

Challenges and constraints encountered by Saudi pre-service science teachers: a critical perspective

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Abstract

Recently, various policies have been implemented in Saudi Arabia to reform science teaching at K-12 levels in order to focus on critical thinking, inquiry-based learning, and problem solving. Research is needed to explore the adequacy of teacher preparation programs to determine whether these programs sufficiently prepare Saudi science teachers to teach according to these new reforms. This study explores the challenges that Saudi pre-service science teachers face in these higher education programs. Results indicated that graduates of the programs studied were satisfied with their experiences; however, various concerns were expressed by some pre-service teachers regarding the theory-practice gap between their university coursework and field experiences, and the supervision structures and functions in place for the professional experiences component. Modifications to the teacher preparation programs are suggested in order to address these concerns and to successfully enact reforms in science education in Saudi Arabia.

Introduction

Preparing science teachers has been a global undertaking over the past two decades of international science education reforms (Wang et al., 2003). These reforms have involved systemic changes at the national and local levels that include interacting subsystems of decision makers, policies, resources, schools, students, parents, and teachers (Shymansky et al., 2010, 2011). Shymansky and colleagues identified teachers as the central link between reforms, instructional resources, classroom practices, and student achievement. Much has been reported about the preparation of science teachers in North America, Europe, and Australia to meet the demands of the current science education reforms; however, less is known about these preparation programs in Africa, Asia, Eastern Europe, and the Middle East.

Policymakers agree that school reform is a major concern, and several movements are trying to change the status quo of education. For example, many teachers are embracing a more student-centered approach to learning (Hamdan Alghamdi & Alsalouli, 2012). However, many top-down approaches ignore factors which mediate curriculum reforms when implemented by actual schools, teachers, and students (Johnson, 2011); these factors include adequate pre-service teacher education and professional development. Additional factors that influence classroom teaching practices, student learning, and the implementation of reform include teachers' perceptions of their preparation, and the challenges and constraints of new classroom practices. The relationships among these factors are closely linked to teachers' strategies for coping with challenges in their daily professional life, shaping students' learning environments, and influencing students' motivation and achievement (Johnson, 2011).

This study focuses on science teacher education in the Kingdom of Saudi Arabia (KSA) and the preparation of science teachers to teach inquiry-based science that emphasizes higher-level thinking. Results are reported from a survey of Saudi pre-service science teachers' feedback regarding their preparation and how they benefitted from their university coursework and field experiences.

Context

The KSA has a population of 27 million, and is the second largest country by area in the Arab world and the largest in southwestern Asia. Most of KSA's population is concentrated in the large cities (Al-Seghayer, 2011). Almost all Saudis are Muslims and nearly 98% are Arabs (Kingdom of Saudi Arabia, n.d.). They are bound together by a high degree of cultural homogeneity, as reflected in their common mother tongue (Arabic), strong family tribal relationships, and adherence to Islam (Al-Seghayer, 2011). These demographic characteristics influence the underlying conditions that affect the framework for educational context and teachers' pre-service education.

Education in KSA is influenced by religious beliefs and traditional values, and schools are segregated by gender, with males and females attending separate schools from Grade 1 (Almunajjed, 1997). This pervasive gender segregation has caused some serious concerns, in particular the lack of women teachers for female schools. In some cases, female students in the Diploma in Education (DipEd) programs, for example, are taught methodology and pedagogy courses by men via closed-circuit TV, which hinders classroom interactions.

In 1953, the Ministry of Education (MoE) was established, which determined national education standards (Ministry Agency of Teachers' Colleges, 2000). The goals were to develop more effective teaching programs, update teaching methodologies, and provide higher qualifications to improve teachers' knowledge.

In the 1970s, attention turned to science and mathematics curricula and the need to enhance those teachers' knowledge and pedagogical practices. Science and Mathematics Centers opened in 1974 to provide intensive pre-service teacher education at the middle-school level. The MoE enacted measures to meet the increasing demands on teachers to address educational innovations. However, these reforms did not provide enough emphasis on teacher preparation and lacked focus on important dimensions in teacher education.

Teacher Colleges (TC's), formed in 1989 at 18 locations, were intended to prepare students for teaching, improve in-service teachers' skills and scientific understanding, contribute to educational research, plan effective programs, and cooperate with other national and international educational organizations. TC students in the 4-year B.Ed. program were required to take professional education courses to prepare them in terms of teaching methods, educational psychology, the KSA education system, classroom management and school administration (Aljabber, 2002).

In addition to the TCs, the MoE developed a science curriculum for elementary and secondary schools that stressed higher-order thinking and problem solving. This major reform in high school science required changes to classroom practices and the preparation of current and future science teachers. The MoE intended to ground the national science curriculum in established research findings about learning and instruction, as well as enhance teacher education and increase the number of female teachers. These reforms required a move toward critical thinking and problem solving in the classroom. For example, teachers are encouraged to acknowledge their students' previous experiences and create meaningful opportunities for new science connections to develop, which could lead to more complex understanding and potential applications of knowledge to unique situations. Consequently, students are more likely to remember what they have learned and to transfer that knowledge to new problems (Clark, 2005). Unfortunately, many pre-service elementary teachers have not experienced such science learning and find it difficult to implement the new curricula and related classroom practices. Student teachers need explicit experience with innovative approaches so they can internalize these ideas and use them in future teaching. Effective science teaching requires engaging course work and professional

experiences for extended times in real classrooms (Huffman, 2006). This is especially true in KSA, given the recent curriculum reforms and standards established by the MoE.

Literature review

Previous studies have examined pre-service teachers' perceptions about their coursework and field experiences. For example, Abdelmoneim et al. (2010) confirmed that numerous U.S. universities and college studies assessed their programs' effectiveness by exploring their graduates' perceptions. Moore (2003) explored teacher candidates' perceptions of their field experiences by documenting their perceptions and their field supervisors' feedback over three consecutive semesters. She concluded that longer field experiences were needed to better prepare and promote teachers' pedagogical abilities. These studies have found that teachers are typically prepared theoretically with little focus on practice in real classrooms, microteaching, or imaginative classrooms. This also appears to be the case in the Saudi context. The Chair of the Committee on Educational Affairs and the Saudi Shura Council of Scientific Research indicated that:

Teachers today suffer from poor preparation and cognitive rehabilitation and skill preparation; blurry tasks, duties and rights; low professional growth programs and supervision; weak accountability and accounting; as well as a decline in society's perception of the teacher, resulting in a low level of job satisfaction. (Al Otaif, 2012, p. 3)

In addition to student teachers' perceptions, the structure of preparation programs has also been studied. Teacher education programs typically focus on three aspects: *content knowledge* (about the specific discipline); *pedagogical knowledge* (about learning, teaching and assessment in general); and *pedagogical-content knowledge* (subject-specific methodology for specific school levels). Science teachers' content knowledge is obtained in undergraduate science courses, while pedagogical knowledge is learned during general education courses. Darling-Hammond & Bransford (2005), Grossman & MacDonald (2008), and Voss et al. (2011) agree that content knowledge alone does not adequately prepare teachers for the classroom. Thus, both pedagogical knowledge and pedagogical content knowledge are also key elements of teacher competence. The U.S. National Council for Accreditation of Teacher Education requires the parallel development of teaching knowledge specific to the content being taught, as well as general pedagogical knowledge of child and adolescent development as applied to teaching (Abdelmoneim et al., 2010). Darling-Hammond (2006) emphasizes that teachers need a combination of content and pedagogical knowledge which incorporates language, culture and community contexts for learning.

In addition to these types of knowledge, field experiences are integral to teacher-preparation programs. Researchers often report that student teachers learn more during field experiences than their coursework. Field experiences are viewed as "real teaching" that allows students to integrate their science knowledge and general pedagogy into science pedagogy for a specific setting. According to Kennedy & Archambault (2012), field experiences are a "vital part of teacher education" (p. 186). However, Johnson (1992) argued that there is surprisingly little understanding of how a field experience contributes to learning to teach; field experiences have not yet been studied carefully (Skamp & Mueller, 2001), particularly in the KSA context.

Previous studies have also considered the challenges encountered by pre-service science teachers. Davis et al. (2006) explored challenges facing new science teachers trying to meet new reform standards, and emphasized the importance of understanding these teachers' concerns. Some studies argue that teacher preparation programs are not sufficiently addressing the concerns of reform-minded science teachers; and Schwarz (2009) indicated that pre-service teachers face challenges in learning how to

teach science effectively. At the same time, student teachers need to develop a repertoire of instructional techniques that can foster productive learning communities as well as professional visions and dispositions for effective teaching. Wilson & Kittleson (2011) argue that pre-service teachers should be prepared

to be facilitators of science learning that leads to understanding, rather than to be teachers of scientific knowledge. (p. 711)

Most of the existing literature discusses pre-service science teachers' (pedagogical) content knowledge (Anderson & Michener, 1994; Cochran & Jones, 1998; Lederman, 1992; Nuangchalem, 2012). Few studies address the challenges facing new science teachers, and none explore these issues in the context of KSA.

Research questions and design

This study explores the challenges that pre-service science teachers encounter in their teaching field experiences. This study investigates the possibility that KSA science-teacher preparation programs are too theoretical and lack field experiences to support teachers' transition into practice and address curriculum reforms. The following research questions are addressed:

1. What are the challenges faced by pre-service teachers in the DipEd program?
2. What are the challenges encountered by the teachers in their field experiences?

This research uses a case study approach and focuses on two groups of pre-service science teachers (one female, one male) at two institutions (one public, one private) in an urban area in the eastern province of KSA. All of the student teachers were enrolled in the same teacher preparation course. Qualitative data were collected on student teachers' perceptions concerning their preparation for teaching, their mentors' feedback, and interview notes collected at three post-field experience meetings. These data were triangulated to reveal localized insights about the teachers' perceptions and challenges. One limitation concerning the qualitative design of this research is that the results are not generalizable to wider samples and contexts; however, the case study method affords an in-depth examination of the perceptions among two groups of Saudi pre-service science teachers, which leads to a fuller understanding of the challenges these student teachers face in the KSA context.

Methods

Overview of study

The student teachers in this study were enrolled in a course called *Curriculum Theory and Pedagogy*, which was taught by the researcher. Instruction to the female group was face-to-face while the male group was taught via closed-circuit TV; thus the interaction was limited for the male group. Topics with both groups included theories of curriculum, theories of learning, and their influences on curriculum and instruction.

This research was conducted with the help of a lecturer coordinator who taught the science teaching methods courses at both institutions; she also mentored a group of student teachers on teaching practicum at four schools and assisted in data collection. During the post-practicum discussion groups, student teachers were encouraged to discuss challenges they faced in their field experiences as novice science teachers. The mentor, who was in their classrooms at least twice during their practicum and

who supervised their microteaching in course sessions, provided written notes and feedback on field experiences, observations, and discussions for this study's purposes.

To make sure that these issues did not affect students' responses or pressure on our students we did our best not to impose on the participants and every step we took was with reassurance to them that their answers were confidential and the data was anonymous.

Participants

Participants were pre-service science teachers enrolled in post-degree teacher-preparation programs (Diploma in Education) at two postsecondary institutions in the Eastern Province of KSA. The total sample ($N = 77$) consisted of 45 female students in a public university and 32 (15 male and 17 female) students at a private university. This sample represented more than 70% of the total enrolment in these two programs. All participants had B.Sc. degrees in chemistry, physics, zoology, or biology before joining the DipEd program. All were preparing to teach in regular K-12 classrooms at the primary, junior high, or high school levels. Informed consent was obtained from all the participants.

Setting

The study took place during the second semester of the DipEd programs. The teachers' responses to a questionnaire were collected during the final month of the program. The field experience included three weeks of classroom experience in elementary, junior high, and high schools. A total of 32 urban schools served as field experience sites. Student teachers were placed in public schools by the university's field-experiences director, according to the availability of mentors; the mentor, however (who supervised and evaluated the student teacher) was assigned by the district school board; some classroom teachers and school administrators were given the authority to evaluate and grade the student teachers. In some cases, only minimal mentoring was provided. An unanticipated issue was that some student teachers did not have a regular mentor, which meant that their on-site supervision was provided by different school personnel.

Ideally, student teachers would teach at least two to four hours per day for three weeks during their field experience with the support of their mentoring teacher. The mentor would visit the student teacher's classroom twice to observe, support, and evaluate their performance and discuss their progress. All student teachers would have an examiner (usually a professor from the College of Education) visit their classrooms once toward the end of their field experience. Given the shortage of professors to cover the entire number of student teachers, some school district supervisors would fulfill this role.

For the group from the private institution, it was possible to achieve nearly ideal mentorship and supervision. However, for the public institution group, mentorship was more difficult to manage. For example, many student teachers did not have a regular mentor and one student teacher received visits from school-based personnel, either a classroom teacher or school principal. This supervision problem was exacerbated because of the lack of organization from the university field experience administrator, which may have been the case because it was the first year of the program and because a large number (55) of the student teachers were scattered around the city in 17 schools.

Data collection

The data were collected from three groups of pre-service science teachers: two groups of females ($N=45$, 17) and one group of males ($N=15$). The student teachers were asked to complete a

questionnaire (see Appendix), mentors were asked for their observation and feedback notes, and the researcher made field notes during student teachers' group meetings after their field experiences.

The questionnaires were distributed by the mentors; student teachers were given one week in which to provide feedback. The questions were designed to explore their experiences and to elicit opinions as to whether the DipEd program had adequately prepared them to teach science. Following Aljabber (2002), the questions were open-ended and were designed to elicit written responses with reasonable validity. Students not involved in this study and the science teaching methods lecturer helped adjust these questions to the current context. Further, the resulting questions were discussed and revised in consultation with a Professor Emerita whose research focus included curriculum and instruction. The revised questionnaire was then provided to another professor who is a faculty member in the Department of Curriculum and Instruction at a British university and whose field is science education. He suggested that the survey questions were appropriate to the purpose and were understandable. Therefore, these two expert reviewers strengthened the claim of reasonable validity.

The questionnaires were then distributed to the participants. Mentors provided observation and feedback notes from each classroom visit. The mentors' notes summarized and evaluated the lesson planning and classroom practices of each student teacher. The researcher's field notes from the three post-practicum meetings summarized the student teachers' general comments about the coursework and their field experience challenges.

Data analysis

Data triangulation was achieved by cross-checking information derived from the participants' questionnaire responses, the mentors' observations and feedback notes, and the student teachers' reflections provided in the group meetings. The 77 questionnaires were interpreted by reading the open-ended responses for each question to determine dominant themes. Female participants were combined into a single group (N=62) as both institutions had similar programs and requirements, but male participants were retained as a separate group (N=15) in order to try and identify any gender differences.

The coding process initially involved the researcher reading all the responses and making brief notes about the themes, which facilitated development of summary sheets. Preliminary codes were developed during the second reading of the responses (Merriam, 2001) as particular ideas, behaviors, and words and phrases emerged as being significant to the identified themes. Codes were sorted into themes, which became the coding categories and subcategories for the third reading of the responses. Another researcher independently coded a selected subsample of the questionnaires ($n = 54$) to determine inter-coder reliability. Inspection of the two sets of coded questionnaires indicated satisfactory inter-coder agreement (~85%).

Responses were coded (in accordance with the questions asked) as Strengths, Challenges/constraints, Weaknesses, and Suggestions for improvement of the field experience; these categories eventually organized the study's results and the supporting evidence. After repeated reading and coding, participants' responses were consolidated into clusters that were reduced to nine stable recurring themes (see next section). Content analysis of the gender-specified responses in these themes revealed no drastic differences between female and male respondents; therefore, all responses were combined. A final inspection of the combined responses reaffirmed the themes about strengths, challenges, constraints, and weaknesses pre-service science teachers encountered in their coursework, field experiences, and the interactions between the coursework and field experiences. Data from the

mentors and the group discussions supported the themes arising from the questionnaire responses and enriched the overall analysis.

Findings

The following discussion highlights the nine themes identified in the data, including illustrative quotes from participants. Quotations are translated from Arabic where necessary.

Satisfaction

Generally, the participants expressed a high level of satisfaction with their teacher preparation program, and they provided insights into the interactions between their academic coursework and field experiences. A majority (~68%; 52 of 77) were satisfied with their specific program, with similar high levels of satisfaction for both programs expressed by females and males. Approximately 80% (62 of 77) indicated that they were highly prepared by the university-based courses and discussions; however, some wished for additional preparation. Approximately 97% (75 of 77) indicated benefits from the field experience but some expressed concerns. According to one mentor's field notes, students believed that

while the coursework was intensive, it served as a platform for the field experiences. The coursework was the theory and, although it was frustrating to study all theories at once, it became helpful to imagine the connection in retrospect.

Another participant stated:

The field experience gave me multiple real-world classroom experiences. We need more field experience. It is the core of the program and for that we should have more time in schools. More guidance and support would make this experience much more informative.

However, participants also listed some challenges encountered during coursework and field experiences. About 32% (25 of 77) believed that a major challenge was the heavy focus on theory rather than on practice. In a follow-up meeting, a student teacher said:

The courses were too much. We covered 18 credit hours per term and I wish the program consisted of 50% for theory and 50% for practice in every course. I want to learn theory of teaching science then work on my skills on how I can be a good science teacher.

Others indicated that they did not have a mentor or faculty supervisor during the field experience; rather, their main classroom teacher or school principal evaluated their performance.

Preparation for the practicum

The majority of pre-service teachers believed that their academic coursework prepared them for teaching science, but they had concerns about the application of this knowledge in the classroom. Participants' satisfaction with the DipEd varied across content, pedagogical and content-pedagogy knowledge domains. Respondents were reasonably satisfied with their content knowledge in science, which most of them had acquired during their B.Sc. program. However, approximately 75% (58 of 77) indicated that while the DipEd provided some preparation, it did not focus on the specific content knowledge required by the science curriculum. In their discussion meetings after their field experiences, some argued that their background in science is very different from current high school science, and it would be beneficial to have courses in the program that focus mainly on the science knowledge related to the levels they will teach. As one participant pointed out:

The theoretical aspects in the science textbook are way more than what I expected and I had to consult my mentor teacher for help in how to explain the concepts to my students. There is too

much information, which was hindering for me and my colleagues. Textbooks are filled with too much data and too little practical activities.

Additionally, 25% (19 of 77) felt unprepared for actual classroom teaching. For example, one student teacher said:

I am not confident in how I can be a good science teacher. How can I raise my students' interest in science and how can I help them to inquire into science knowledge? In the constructivist theory, I have to build on their prior knowledge but how can I do that?

A participant in the meetings stated:

I feel that I should have micro-teaching with my mentor prior to the classroom teaching. This way I could check my knowledge in science and my confidence when I explain the science concepts to my students.

Another said:

In order for me to 'walk the talk' I need to put myself in my students' seats. I need to be prepared to help improve my students' learning and make sure that they enjoy the process sometimes. I doubt my abilities to do both... I feel that I need help to get there.

This area of concern involves the respondents' self-efficacy and strategies to enact a science-as-inquiry teaching approach. Many participants' knowledge concerns were not about pure science but about science pedagogy. They were aware that the new instructional approaches required more than simple lectures on science concepts; however, they were not experienced enough to identify that they needed in order to integrate their knowledge of science and pedagogy.

Theory and practice

The pre-service teachers identified the theory-practice gap to be a major concern about their teacher preparation programs. Although most in this study were satisfied with their program overall, after the field experience their concern about the link between the coursework and field experience was apparent. One responded in the following way:

Some courses were too theoretical and did not help us connect theory to practice. Most of the courses could not be transferred to practices in my field experience. We need more time in the science methods teaching course. We need to learn more science teaching strategies. We need more focus on classroom management, assessment, learning processes, and individual students' characteristics.

Findings show that the concern about the theory-practice gap increased during the participants' field experiences, where their cooperating teachers were also struggling with inquiry teaching approaches or had totally rejected these student-centered approaches.

The student teachers are placed in the conflicting influences of a triad of influential others: the university professor, the student teaching supervisor/mentor and the co-operating teacher. Frequently, student teachers side with the cooperating teachers, who seem to represent the real world of teaching, and university professors have the least influence as they are viewed to be part of the 'Ivory Tower'. The supervisors/mentors need to bridge this perceived realism divide and theory-practice gap (L.D. Yore, personal communication, February 9, 2013).

Indeed, one student teacher said:

Although I understood well the developmental appropriateness of various strategies to be employed when teaching science, I sometimes become more interested in using a certain method to teach a concept just because I liked and enjoyed it; although, I would have taught it differently when I

consulted the class teacher. He was open to such approaches, but I know that my professor would not be.

One mentor's report said:

Pre-service teachers associated more with their classroom teachers' advice than with their professors' advice because professors had been out of the field for many years, and they might have lost contact with science teaching in practice. It's different than the theory. Practice makes perfect, and this is why we go with the teachers' ideas.

Responses indicated that the main challenge of the field experience, as expressed by 80% (62 of 77), involved how novice teachers can transfer theory into practice. One respondent said:

The courses did not prepare me to be good teacher. I need more pedagogical knowledge to use in classroom management and dealing with students' diverse abilities.

Again, these practice-oriented participants do not view general pedagogical knowledge separately from its application in real classroom situations with real students.

Areas for improvement

An overwhelming majority of participants believed the field experience was effective, but they identified areas for improvement. Overall, 97% (75 of 77) found the field experience useful; 80% (62 of 77) focused on personal advantages of the field experience, especially as an opportunity to practice public speaking. According to one participant: "It raised my confidence in myself. I couldn't speak in public and that was a big bonus of the internship". Another commented: "The experience gave me the ability to test my ability to lecture and convince and engage in dialogue".

The concern about the public performance component was not surprising, considering the cultural conventions regarding women in KSA. The two comments above were written by female teachers and female student teachers tended to express this belief about public speaking more often than male student teachers did.

Others indicated that one major challenge was their fear of facing students. One participant said:

I always felt short of breath. I forget what I want to say. I wish I was trained to break the fear barrier before facing a classroom of high school students.

In the discussion notes from the meetings, another participant was quoted as saying:

The Diploma program should have helped me work on presentation skills and communication skills. I do not feel that I have enough experience to be confident and feel that I am enjoying it. It is the same with my ability to manage time. Until now, I didn't feel that I could manage a classroom full of students.

Concern about the short length of the field experience was expressed by 80% (62 of 77). The limited teaching prevented many from becoming fully engaged and confident; it takes effort and repeated opportunities for novice teachers to learn how to explain abstract scientific concepts to students. Participants became overly involved in procedural matters rather than pedagogical-content issues. Some continued to face difficulties in practicing instructional decision-making and using real-time student feedback to make adjustments to planned activities.

Approximately 64% (49 of 77) found it challenging to focus on pragmatic and pedagogical issues. One participant asked:

How can I focus on methods and strategies of teaching for a science period that is 45 minutes? I keep thinking about this. The time I have is too short. I need to get used to limiting my theoretical framing of the lesson I am covering in the class period I have. I should focus more on classroom practices.

In addition, some participants were concerned that the field-experience time was not sufficient for them to engage with classroom teachers and with the school environment.

Mentoring

The participants believed the relationship with their professional education advisors was the most critical feature of their preparation. Field experiences were highly valued and student teachers wanted more opportunities to engage in authentic preparation. This belief was closely tied to an associated belief that their field experience mentors were essential to the effectiveness of these experiences. Approximately 65% (50 of 77) believed that the field experiences and the supervisory personnel involved in these activities led to professional collaboration, and that the effectiveness of the clinical supervision was the most valuable part of the diploma program. As explained earlier, their mentors performed the dual roles of supervisor and evaluator. The supervision function facilitated the student teachers' reflection on their actions while moving them toward real-time reflection-in-action. Moreover, the supervisors provided supportive guidance in resolving difficulties, planning for future teaching, and negotiating conflicting perspectives about science teaching between the university professors and cooperating teachers. For the student teachers, this supervision provided an important window into their own teaching career. The evaluation function was a university necessity, which the student teachers accepted. One student teacher wrote:

I was happy that someone with a lot of experience in the field gave me her feedback on my teaching. She has been in the field for 20 some years. How can this be less appropriate than the feedback I would have had from a university professor?

However, some indicated that their supervisor/mentor relationship was less successful or lacking. One respondent stated:

We had a lack of supervision, which made us feel left out. That experience was inefficient, especially because some of us were evaluated by the class teachers and/or the school principals.

Co-operating teachers as evaluators

A sizeable minority of the participants indicated that having their cooperating classroom teachers as evaluators of their performance hindered their progress for various reasons. In both DipEd programs, cooperating teachers in the host schools had multiple roles: role model, professional colleague, and evaluator. Approximately 40% (31 of 77) suggested that the evaluation function interfered with the collegial relationship. For example, one participant said:

The teacher was not qualified to evaluate me. She attended only once. How can she know my teaching style and ability?

Another respondent said:

The teacher was from a different Islamic sect and she wanted to discourage me. It is not fair. I expected a supervisor from the school board or the university like my other colleagues. It left a bad taste in my mouth. I was not prepared for the classroom teacher to come into my class and evaluate me.

A mentor reported that one pre-service teacher said:

Although I am more inclined to believe that the class teacher was closer to the field than my professors, I felt more nervous to be evaluated by her or by the school administrator [...] than by my professor, who would have been more reasonable as she knows me better.

This should raise a concern for teacher preparation programs that do not have enough specialized science mentors and have current teachers and school principals evaluate pre-service teachers. It is

important to have evaluators who are well versed in the competencies needed for science teacher education.

Effectiveness and need for support

The effectiveness of science mentors, cooperating teachers, and the school administration to guide and support pre-service science teachers' professional growth was a concern for some participants. Science mentors and collegial support were identified as critical features of successful field experiences, but the availability and quality of this supervision varied. For some, the supervision function that identifies strengths and weaknesses, and provides appropriate remediation and encouragement for the student teacher, seemed to be missing. This is problematic in many teacher preparation programs, especially when the need is in a content specialization like science. The mentors, cooperating teachers, and school administrators must establish credibility, social capital, and trust with the supervisee. Both content expertise and recent science teaching experience are required for credibility, while social capital and trust are incrementally developed over time. Approximately 40% (31 of 77) felt that they did not receive enough attention from their mentors during their field experience. Approximately 60% (46 of 77) indicated that the collegial support was not there in their experience; however, they realized how important it is to have feedback from all levels, including colleagues, mentors, and evaluators.

Other support

The pre-service teachers identified a lack of on-site support, equipment and supplies, and early visits to host schools and classrooms. Many participants indicated that not having enough host school support for field experiences caused a great deal of stress. For example, one mentor's field notes indicated that a group had agreed

that their whole experience could have changed if they were supported when they needed the laboratories [for a] science experiment; [...] some material was not available, and the school administrators did not seem to do anything about it.

Another student teacher said:

There is lack of equipment and laboratories in the school where we went to do our field experience. This caused many students to be disinterested in science concepts. Not having the proper space to do the experiments made students unappreciative of science periods. It seems boring and meaningless for students nowadays. This generation is very visual; they need to see in order to understand.

The lack of equipment and materials is an issue that experienced teachers in KSA have complained about, especially how detrimental it is for effective inquiry-oriented science teaching required by the new science curriculum (Authors, 2012).

Another participant said:

[The field experience] was a stressful period for me. Only when it was over did I realize how much I missed because of a lack of psychological support.

The discussion notes and mentors' reports indicated that some student teachers struggled because they did not have someone readily available to consult with when they needed help. One student teacher asked for

connection via a social network, like Facebook or Twitter. It would make a difference for many of us who are on the Internet often.

In the preparation program, it is important for student teachers to learn to stand alone as practitioners in order to increase self-efficacy and willingness to take on more challenging tasks. Findings from this study suggest that some participants did not feel confident to teach independently. A three-week field experience may be too short for some student teachers to achieve the needed level of self-confidence.

Approximately 65% (50 of 77) suggested that it would be greatly beneficial to have had school visits prior to their field experience, especially to become familiar with the school's science materials and laboratories. One respondent suggested:

It would be better if we get into schools earlier in our programs. We need more experience with students before our field experience starts.

In addition, mentor reports indicated that 45% felt that an orientation earlier in the school year could have better prepared them.

Teaching methods and school awareness

The pre-service science teachers suggested that some of the teaching methods they had planned to use during the field experiences were not appropriate for the classrooms or the students. Moreover, decisions about instruction needed to consider the students, resources, and environment, which are not known prior to the start of the field experience. Some indicated that they had planned to use a variety of teaching methods such as dialogues, active learning, cooperative learning, problem solving, brain maps, exploration, research, using technology for learning, critical thinking, discussion, and focusing on real-life situations. They believed that these methods were within their capabilities and would help students learn science concepts and higher-order thinking. Approximately 90% (69 of 77) indicated that they would use active learning, collaborative learning, and scaffolding to teach scientific concepts. However, findings from the questionnaires and mentor reports revealed that these expectations were not met. Some found that using a consistent method to teach scientific concepts made better sense for novice practitioners rather than using different methods in every lesson. Thus, when student teachers were asked about the teaching strategies they used, they indicated using collaborative teaching approaches (98%), inquiry-based approaches (95%), problem solving (45%), critical thinking (25%), brainstorming (20%), and lecturing (20%).

Responses indicated that 20% believed that they became better at decision-making because of their field experience. They commented that, when they get future teaching opportunities, they will not only teach but also be able to observe the school environment, arrange their schedule, and attend as substitute teachers. One pre-service teacher added:

The field experience was very useful as it helped me in understanding how to get close to students and understand their diverse abilities in science juxtaposed with their development.

About 60% (46 of 77) felt that their exposure to students for the first time allowed them to practice what they had previously learned about respecting differences among students' diverse abilities.

Discussion

The findings of this study indicate that education reforms need to consider the subsystems within the education system, not just mandate policy and curriculum changes. In KSA, science education reform needs to consider changes in learning outcomes and instruction that, in turn, influence classroom practices and student achievement. Moreover, the curriculum and instruction changes need to be reflected in the professional learning of current and future science teachers.

This study explored pre-service science teachers' perceptions concerning their coursework and field experiences in two KSA teacher preparation programs. One finding was that pre-service teachers tend to judge the overall program according to loosely integrated models of knowledge, beliefs, and skills. For instance when teaching about the periodic table in science they would bring in detailed information about iron and its look, smell and uses, but not much about the details of its properties if they are teaching advanced levels in science. The participants were generally satisfied with their preparation; however, they also expressed concerns. Specifically, they were concerned with the linkage between their coursework and field experiences, and aspects of the program's content, placement, staffing, supervision, and performance evaluation practices.

Many of the themes identified in this study did not exclusively apply to content knowledge separate from pedagogical knowledge; most strong concerns were related to pedagogical-content knowledge, namely how to teach science topics to specific groups of students. These DipEd programs assumed that participants acquired their science content knowledge during their B.Sc. program and, therefore, the campus-based coursework focused mainly on pedagogical knowledge about teaching and learning in general, leaving the integration of content and pedagogical knowledge to the science teaching methods course and the three-week field experience. This knowledge about to teach elementary/secondary science can be constructed partially in science teaching methods courses and more fully in authentic learning-teaching environments with the support of a more expert teacher and a receptive group of students. Many pedagogical content ideas are understandable when viewed through the lens of contemporary theories of human learning (Bransford et al., 2000; Duschl et al., 2007). However, a detailed understanding is constructed *in situ* and over extended periods of time in diverse teaching experiences involving different topics, grade levels, and students.

This study has brought to light several implications for science teacher preparation. When preparation programs, field sites and experiences, and current practices are understood differently by diverse stakeholders in the system, it is unlikely that those involved will be fully satisfied with the outcomes of the programs. Skamp & Mueller (2001) noted that

intensive collaboration between practicum schools, sponsors teachers, and university personal is required. (p. 243)

The examples of successful field experiences in this study were cases where the university, school, teacher, mentor/supervisor and student teacher held similar expectations, and the structures and functions were in place to facilitate these pre-service science teachers' professional learning, development, and growth.

Participants in this study identified their professional relationships with their mentors and cooperating teachers as being critical. However, the evaluation function and the shortage of fully qualified science mentors suggests that technology and social networking be employed to maximize observation effectiveness and communication among student teachers, mentors, cooperating teachers and colleagues during the field experience. Shymansky et al. (2011) successfully utilized Internet-based and video-communication networks to facilitate professional development and teacher-to-teacher collaboration among elementary school teachers of science across two U.S. states, and Raven & O'Donnell (2010) describe the use of a social network tool for students on work experience in the UAE. Information communication technologies, such as social networks and Skype could allow pre-service teachers to access just-in-time science teaching expertise as needed and to network with other pre-service teachers facing similar issues. Remote access video systems allow more frequent classroom observations by qualified supervisors/cooperating teachers and post-observation supervisory interviews to facilitate reflective practice.

Another challenge indicated from the field experience is the disagreement among currently practicing teachers concerning school curricula, the reality of students' lives, and the teaching theories to which the pre-service teachers were exposed in their diploma program. Practicing science teachers worldwide have been slow to implement inquiry teaching and science education reforms (Yore et al., 2007). Therefore, it is likely that student teachers will be placed with practicing science teachers who have not fully implemented or have rejected inquiry-teaching approaches. Moore's (2003) analysis identified

the need for pre-service teachers, their supervisors, and their mentor teachers to examine and discuss the rationale behind pedagogical decisions. Building trust among pre-service teachers, mentor teachers, and university faculty to confront differing conceptions of practice is integral if theory is to actually inform teaching. (p. 40)

There were examples of this reflective practice in this study, supporting Lee's (2005) finding that student teachers became more reflective and changed their concerns from self-oriented to student-oriented issues once they started their teaching practice. However, these participants did not have sufficient time to develop their reflective thinking as far as teacher educators would like. (p. 713)

Another finding that reflects pedagogical implications is the theory-practice gap. This gap can be remediated if pre-service science teachers develop a frame of reference for pedagogical decision-making during their studies. European studies (Barone et al., 1996; Korthagen & Kessels, 1999) have suggested that many teacher programs consist of courses in which theory is presented without much connection to practice. Ben-Peretz (1995) highlighted that teacher education curriculum tends to communicate a fragmented view of knowledge, both in coursework and field experiences. These studies, in addition to the current research findings, highlight the need for integrative teacher education programs in which pre-service teachers are exposed to as much theory and practice as possible in a progression of diverse learning-teaching environments. In this study, spending a majority of program time on the theoretical framework of education and philosophical concepts around teaching and learning, with little focus on the pedagogical implications of how to teach science, was met with frustration; and this feeling has been expressed also in the literature on teacher education. Other studies have emphasized that the focus on expert knowledge (Sprinthall et al., 1996) has remained unchanged for many decades, although many studies have shown its failure to strongly influence the practices of graduates from teacher education programs.

While this study highlights issues around supervision/evaluation structures and functions, it also raises possibilities about how to develop successful peer relations, peer tutoring, and peer evaluation to better understand instructional strengths/weaknesses and promote reflective practices. Several well-documented observation protocols, such as the Local Systemic Change observation protocol (Horizon Research Inc., 2000) and the Reformed Teaching Observation Protocol (Sawada et al., 2002), can help novice teachers identify indicators of effective subject teaching and internalize these indicators. Although some student teachers struggled as novice practitioners, especially in finding support, this study's findings highlighted the importance of establishing successful peer relationships. Peer tutoring and peer evaluation will not fully replace the mentor's or supervisor's evaluation function, but it is a potential supplement. This suggestion is reflective of the mentoring program offered by the Alberta Teachers Association, which would be recommended for teachers in this context (Sanford & Hopper, 2000).

More than 50% of participants in this study indicated that they had issues with understanding and teaching the scientific concepts they were assigned, and with grasping the reformed science curriculum and textbooks implemented in KSA schools since 2008. However, all participants had B.Sc. degrees in science domains. Thus, they were not lacking abstract knowledge about science, but rather knowledge

about how to (a) deconstruct and present science ideas in easy-to-learn progressions and sequences, (b) access and challenge students' prior knowledge about the target ideas, and (c) demonstrate these ideas in learner-appropriate ways. Many were not comfortable using informal formative assessment to inform their instruction and empower students' learning (Ruiz-Primo & Furtak, 2007, p. 79).

Student teachers' concerns about self-confidence and self-efficacy regarding science teaching could be related to frustration with the amount of information to which they were exposed in a short period of time and their limited time to unpack the complexities of science teaching. Teacher education programs should foster teachers' communication abilities, self-efficacy, and self-confidence. Results revealed how teachers had struggled with believing in their ability to teach, which raises questions about personal attributes, career choice, training, and the university's selection process. Some studies have suggested that these uncertainties could affect teacher retention. Elliott et al. (2010) suggested that the remedy would rely on the

supervision and professional development (induction) activities that encourage, support, and retain early career teachers in the first three to five years of service. (p. 132)

Successful implementation of any educational innovation involves planned or managed change over an extended duration, whereby incremental steps forward are consolidated before the next steps are enacted (Shymansky et al., 2011; Yore et al., 2007). On the international level, science education reform continues to be one of the challenges facing pre-service science teachers. As Sandifer & Haines (2012) write:

Much of what we know about the factors that support or hinder science teaching reform are derived from educators' reflections on reform efforts that were briefly successful, and then abandoned — such as the relatively short-lived science-as-process teaching reforms. (p. 3)

This study found that one challenge to which these pre-service science teachers responded was their inability to fully engage the innovative methods and strategies for teaching the new science curriculum.

Conclusion and implications

This study examined the challenges Saudi pre-service science teachers faced in their DipEd program during their campus-based studies and teaching their field experiences. The results of this study suggest several implications for the development and design of teacher preparation programs and curricula.

Firstly, this study emphasizes the need to change the planning and structure of the pre-service field experience. Following Moore's (2003) suggestion, the inclusion of more learning-teaching experiences prior to the student teachers' actual field experiences would improve the program. For example, participants suggested that early visits to schools, classroom observations, and meetings with their cooperating teachers and assigned mentors at the host schools would have been helpful. The science education literature has identified other potential learning-teaching opportunities in informal environments that would not increase the pressure on school placements (Bell et al., 2009). Additionally, participants made specific supervision and evaluation suggestions about the field experience. Adding these components could help student teachers overcome one of the major challenges highlighted in their responses, namely the short field experience in the DipEd program.

Secondly, this study found that these DipEd programs seemed too theoretical and lacked the clinical preparations novice teachers need. More emphasis is needed on classroom-related knowledge, including content knowledge, pedagogical knowledge, and pedagogical-content knowledge. These programs committed most of their course credits to general pedagogical knowledge and only one

course and a three-week field experience to developing understanding of teaching science in specific contexts. These allocations to field experience and to discipline-specific methods are below international standards.

Thirdly, the programs in this study need to dedicate more effort and time to supporting pre-service science teachers' reflection during their field experience. Indeed, teachers need to learn more science and engineering practices, such as critical-thinking strategies that promote argument, critique, interpretation, analysis, inference-drawing, valuation, explanation, and self-correction (Abdelmoneim et al., 2010). Moreover, future programs should include an increase in field experience variety, time, and teaching opportunities for each student teacher prior to full-time engagement in the field upon graduation.

Fourthly, another major difficulty was the lack of close mentorship, or any mentorship at all. This suggests that cooperating teachers and university faculty should be aware of the goals of the teacher education program and provide ample time (preferably together with mentors/peers) for student teachers to analyze observed lessons as well as their own teaching. The student teachers should have opportunities to experiment with the ideas developed in coursework. Above all, this study provides insight into the development of experiences that could be incorporated in a teacher-education program that would better equip pre-service science teachers in KSA to prepare for their future teaching.

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Appendix

Science Preservice Teachers' Interview Questions

1. Did you benefit from the Field experience?
2. How satisfied are you about the science preservice teachers' preparation science program (the general, the educational, and the major preparation)?
3. How effective do you feel the major courses are to your future teaching life?
4. What is your opinion of the number of hours that you studied in the general, the educational, and the major preparation?
5. How helpful is the student teaching semester (internship) for your teaching?
6. How important do you think the general and science teaching methods courses are for your teaching?
7. How well prepared do you think you are to encounter various difficult educational situations in real-life teaching situations?
8. What are the most important courses that you think have a positive impact on improving your scientific and educational knowledge? Why?
9. What are the least important courses that you think have a negative impact on improving your scientific and educational knowledge? Why?