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SCIENCE TEACHERS' TYPOLOGY OF CPD ACTIVITIES: A SOCIO-CONSTRUCTIVIST PERSPECTIVE

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ABSTRACT. This study presents a typology of continuing professional development (CPD) activities and provides a discussion related to each. The typology includes 2 main themes, which investigate the various types of activities and the content presented in CPD programmes. The study used qualitative methods (open-ended questionnaires in addition to semi-structured interviews) with Saudi Arabian science teachers. The main theoretical framework for this study centres on the socio-constructivist theory of learning. Discussion of the findings leads to a depiction of what science teachers 'need' to learn and 'how' they want to learn. The aim of this study is to provide a framework for socio-constructivist science teacher professional development based on an attempt to understand how teachers learn effectively in CPD programmes and what science teachers need to learn.

KEY WORDS: continuing professional development (CPD), CPD activities, socio-constructivism, teacher learning

Introduction

Effective continuing professional development for in-service teachers is essential for creating effective schools, as it may promote the quality of teaching and learning in schools (Kennedy, 2005). After the emergence of the standards movement (AAAS, 1993; NRC, 1996; NCATE, 2001, 2002) and the low achievement of Saudi Arabian students in the 2003 TIMSS, the goals for science teacher education in Saudi Arabia have been reshaped. Teacher professional development is now widely recognised as a national priority in Saudi Arabia (Alshamrani, 2012). Nonetheless, science teachers in Saudi Arabia seem to be faced with continuing professional development (CPD) programmes that present content that does not reflect professional or scientific needs (Mansour, Alshamrani, Aldahmash & Alqudah, 2013). There are also cases where the types of activities that CPD providers utilise to deliver the content do not match the preferred type of learning by the science teachers in attendance (Mansour, EL-Deghaidy, Alshamrani, Aldahmash, 2014).

Such a mismatch between ready-made programmes and those that are based on needs, in addition to transmissive activities in contrast with constructivist activities, could be seen as major factors in ineffective CPD programmes (Dillon, Osborne, Fairbrother & Kurina, 2000). Therefore, the aim of this study

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is the depiction of what science teachers need to learn and how they want to learn. Given this, the main emphasis of this study is providing a framework for socio-constructivist science teacher professional development based on an attempt to understand how teachers learn effectively in CPD programmes.

Despite having science-reformed curricula in schools, which promote constructivist philosophies, CPD programmes have not been reformed. In this sense, they seem to be missing out teachers' needs and preferred ways of learning that should be taken into consideration in reformed CPD programmes (Mansour et al., 2013). Previous research by the Excellence Research Centre of Science and Mathematics Education shows the significance of engaging critically with teachers' voices and views of their CPD programme. Providing a mechanism for individuals to reflect and assess their professional needs and giving them a voice that empowers them and provides a roadmap for development are some of the issues that need to be taken into consideration to enable the concept of lifelong professional learning to be implemented (Mansour et al., 2014). From this perspective, teachers' views and self-evaluations are practical indicators, providing a good estimation of teachers' experiences and establishing the framework for future teacher professional development.

Theoretical Framework

The theoretical framework for this paper centres on the socio-constructivist theory of learning. The justification for such selection is that through this theory teachers could voice 'how' they prefer to learn and 'what' they want to learn by viewing teacher learning as the focus of professional development programmes. The socio-constructivist theory is based on Vygotsky's (1978) understanding that knowledge is constructed in a social context where learning occurs through discourse with others. In the context of professional development, teachers could be considered as learners where there is a focus on their previous knowledge, skills and beliefs; opportunities for feedback, revision and success; and interaction with others (Bransford, Brown & Cocking, 2000). The bases for this view come from a cognitive psychological perspective (Putnam & Borko, 2000), when favourable learning environments are provided in which teachers are responsible for their own learning (Bransford et al., 2000). Within this favourable context, the teacher cognitively engages in the construction of knowledge through social processes and active

engagement that change teachers' instructional practices. Such change results from constructing knowledge in a supportive social context with time for reflection and revision (Kreber, 2006). Garet, Porter, Desimone, Birman & Yoon (2001) acknowledged the role of teachers' active engagement in meaningful discussions, planning and practice as a core feature of professional development programmes.

Teachers' Learning and Change

From the above illustration of the main features of socio-constructivism, it is clear that teachers need to be prepared and qualified with extensive learning opportunities on how to apply such constructivist-teaching practices in their classrooms, especially if this were to be part of a reform action (Borko, 2004; Loucks-Horsley, Love, Stiles, Mundry & Hewson, 2003). Reform in science instruction has been an issue of concern (Appleton, Ginns & Watters, 2000), particularly as previous research documented that science instruction is often textbook-oriented with little science inquiry (Crawford, 2007; Jones & Eick, 2007). The study acknowledges that science curriculum change can be mandated through new syllabi and associated documents, yet effecting change to teacher professional practice is more complex (Peers, Diezmann & Watters, 2003). The starting point, according to the focus of this study, is CPD programmes which, in general, are aimed to enhance teachers' content knowledge and improve classroom practices (Desimone, Porter, Garet, Yoon & Birman, 2002). Yet, a number of researchers argue that any process of change needs to be mindful of teachers' motivations and attitudes (Robinson & McMillan, 2006; Welmond, 2002).

When trying to sketch out the qualities of a teacher in a socio-constructivist classroom, these can be summarised by the emphasis on the role of pedagogical content knowledge (PCK) and the teachers' ability to engage their learners in continuing knowledge construction and reconstruction. These qualities need to be considered in both teacher education and professional development programmes. Yet, since the focus of this study is on teacher professional development, it limits its theoretical background to the concepts of teacher learning that could affect teachers' tendency to move to socio-constructivist practices in their science classrooms. In such context, Avalos (2011) sees that the core of professional development (PD) programmes is understanding how teachers learn, how they are involved cognitively and emotionally and how they transform their knowledge into practice.

Based on the notion of change and teacher learning, this study perceives CPD as the main vehicle to bring about change, particularly those programmes that have constructivist activities at their forefront. CPD programmes with such an aim claim to have the capacity to positively impact teachers' learning and practices in the classroom (i.e. Darling-Hammond, 1997). But for this to happen, CPD programmes need to be structured and planned using a 'bottom-up' approach that is based on teachers' professional and scientific needs rather than the 'top-down' one-shot programmes and settings that are commonly found across various nations (Clarke & Hollingsworth, 2002; Sleegers, Bolhuis & Geijsel, 2005). Moreover, CPD programmes should provide opportunities for teachers to actively collaborate and discuss issues of mutual concern in a favourable and meaningful environment. For this to happen, providing links to teachers' daily classroom contexts with such new experiences could help facilitate the shift from the transmissive view of learning and teaching to a more constructivist view. Therefore, the premise upon which this study is mooted is the definition of learning that recognises socio-constructivism, where social learning contexts are at the core, whether we are discussing teacher learning or student learning. Thus, understanding how teachers 'learn' is essential for developing successful professional development programmes. Research on teachers' learning shows how it draws on both discourse and practice perspectives (Goos, 2008).

CPD Activities

In an attempt to deepen the understanding of CPD and its potential to improve teacher learning, the authors reviewed previous literature on details of the CPD activities. Continuing professional development activity is described as all learning activities undertaken throughout life with the aim of improving knowledge, skills and competencies within a personal, civic, social and/or employment-related perspective (European Commission cited in Austin, Marini & Glover, 2005, p. 5). It is documented in the literature that most CPD activities offered are 'traditional' and 'transmissive'. According to Garet et al. (2001) and Weiss, Banilower, McMahon & Smith (2001), 'workshops' are the most commonly found type of activities that is used in professional development and the most commonly criticised type as well. They are known as the typical 'one-shot' workshops that deal with decontextualized information and often do not resonate with teachers' perceived needs (Bransford et al., 2000). They are also seen as

ineffective in providing teachers with sufficient time and content necessary for increasing their knowledge, let alone providing the stimulus for meaningful changes in their classroom practice (Loucks-Horsley et al., 2003). Other types of activities that fall under this traditional category of CPD activities are 'conferences' and 'courses' that require surface levels of learning and participants' passive roles.

The inadequate effect of traditional types of CPD activities led to introducing what is termed 'reformed activities'. According to Garet et al. (2001), who included science and maths teachers, reformed activities were the ones that could help make connections to the classroom teaching and be sustainable over time. This is because these activities take place in schools and are provided by mentors or coaches who spend quality time to guide and direct. With reform activities, there could be space for catering and responding to teachers' needs and goals and, therefore, they have a positive effect on changing classroom practices (Chval, Abell, Enrique, Musikul & Ritza, 2008). Another form of CPD activities is 'paired professional development' where two teachers work together over a period of time while they focus on a topic that has mutual interest to them both (Pharr, Starr & Edwards, 2009). In addition to the types of activities above, Robson (2006) grouped 'work-shadowing', 'team teaching' and 'peer observation' under what could be called 'informal or non-formal CPD activities'.

Context of the Study

Teacher education in Saudi Arabia is shifting these days because of the establishment of a new structure for higher education; in this new structure, all teacher preparation programmes must operate under the Ministry of Higher Education instead of having some of them operated under the Ministry of Education. However, current in-service science teachers graduate from either colleges of education or colleges of science; some of those teachers who graduate from colleges of science go through a 1-year educational programme before or after being officially appointed as teachers.

The educational system in Saudi Arabia is centralised; the Ministry of Education sets the regulations and school curricula that must be followed by all teachers in all schools across the country. It is also a single-gender education in which male students are taught by male teachers and vice versa. Science is taught in all elementary and intermediate grades as 'general science'. For the first secondary grade, all students study three science courses: physics, chemistry and biology. For the 11th and 12th

grades, only scientific track students study the three courses as well as a geology course.

Currently, science education in Saudi Arabia is under a reform process which was launched in 2009; the McGraw-Hill series in science was translated and modified to be adopted by all school levels. Alshayea & Abdulhameed (2011) indicated that the adopted textbooks supported inquiry-based learning, scientific literacy, science and technology. However, Aldahmash & Alshamrani (2012) found that science teachers were still attached to the traditional methods of science teaching.

The attention given to providing teachers PD programmes was initiated in 1975 under the *General Administration of Teacher Preparation Programs*. However, it was not until the launch of the current reform of science education that special PD programmes are provided and dedicated to science teachers. Teacher PD is directed and supervised by the general training department at the Ministry of Education (MoE). The training programmes are provided through specialised centres in each educational administration that are under supervision from the Saudi Ministry of Education. Teacher PD aims to upgrade science teachers' proficiency and teaching skills in general areas such as 'classroom management' and 'educational technology'. Specific programmes are also held, especially when there are plans to introduce new curricula or teaching approaches. Science teachers teaching in secondary, intermediate and primary schools attend training programmes together, although female and male teachers receive their training separately due to the gender-segregated system in the country. The training section located at the MoE sets out the training plan for the year and sets out the training schedule and locations through this centralised system. The estimated number of training programmes provided in Saudi Arabia for teachers is ten programmes per year with about 25–30 trainees in each. The programmes include topics such as active learning, inquiry-based learning, differentiated instruction and conceptual change. According to the training section at MoE, PD takes place according to two main types: the first is through short-term PD programmes that are less than 2 weeks through national programmes that target specific needs and stimulation programmes that run for a short duration of 3–5 days maximum that usually take place before the academic year. The second type of programme is much longer and could last for a semester or a whole year and takes place mainly through university courses. In both cases, female and male teachers have the same

access opportunities yet attend separate programmes due to cultural issues in the country.

Methods

Research Questions

1. What are science teachers' perceptions of the activities that can be found in CPD programmes, and what are their preferences of such activities?
2. What are science teachers' pedagogical, professional and scientific content needs from CPD?

Research Methodology

This study was based on an in-depth study of the perspectives of teachers who had participated in CPD programmes or activities in the last 5 years. The methodological approach adopted for this purpose is mainly qualitative in nature where qualitative data were collected through an open-ended questionnaire survey (Appendix), followed by in-depth semi-structured interviews leading to the development of a 'thick' description of CPD from the teachers' perspective (Appendix). The interview protocol was developed by the researchers and then reviewed by five experts in science education to assure its content validity. The open-ended questionnaire and interviews were shaped by a concern to understand more about the following facets of CPD identified as key in the literature and, indeed, in much of our own recent research:

- Current CPD types of delivery and content offering
- Teachers' CPD content needs
- Teachers' learning activities
- CPD provision
- Benefits, status and effectiveness of CPD
- Planning of CPD
- The school context of CPD

The study was carried out in two interrelated stages. The first stage was by administering the open-ended questionnaire. The findings of this stage acted as a springboard for the next stage. The second stage included interviews with a sample of nine teachers drawn from the questionnaire sample. The findings of these two stages represent an in-depth

understanding of teachers' perspectives of their experiences with the CPD activities and their motivation to participate in CPD programmes.

Research Participants

The population of this study was all science teachers in three educational administrations in Saudi Arabia (Mecca, Taif and Majmah); the total number of teachers in these administrations was 3,150. These three specific educational administrations were chosen as they have an agreement with the centre funding this research study. However, for the sample of this study, the researchers targeted one third of the population since the main aim was to understand the PD practices and experiences happening rather than generalising results. Therefore, not all of the educational districts were selected, as responses of teachers participating in the study would give a possible indication of their experiences through attending PD throughout 5 years. The criteria used in the selection process took into consideration covering both urban and suburban areas in each administration. Three out of nine educational districts under Mecca educational administrations were selected. For the Taif administration, three educational districts out of ten were selected. For Almajmah, two educational districts out of four were chosen. The total number of teachers in the selected districts was 1,052 (485 males and 567 females). Nonetheless, this paper reports on responses from the secondary-stage teachers who were part of the sample of the study, whereas findings from teachers at the other stages could be found elsewhere (Mansour et al., 2014).

The researchers contacted the schools' principals, asking permission to conduct research in the school. Upon approval, the researchers sent each school the questionnaires with a cover letter explaining the purpose of the study, assuring teachers of confidentiality (no names required) and stating that filling in the questionnaire was on a voluntary basis. A total number of 304 teachers responded to the open- ended questionnaires, with a response rate of 29 % of the total sample. This is a limitation that the authors acknowledge, and therefore, in future studies, a different perspective will be used in order to ensure a higher response rate. One of them is the use of incentives for those who return the questionnaire on time, while the other is to allocate a representative on behalf of the authors to take this role and ensure teachers' positive response. Nonetheless, from the 304 responses, 167 were from the secondary stage as the focus of this paper. The respondents included 52 male teachers and 115 females. They were asked a range of questions about their personal

experiences of CPD and their reflections on CPD within the present education system in Saudi Arabia. Additionally, we carried out nine interviews with science teachers (three females and six males). The initial number of teachers who agreed in the questionnaire to be included in the study further was 23 teachers with 16 male and 7 female teachers. Since the introduction of the interview stated that participation is voluntary and teachers could withdraw at any point, eight teachers left while the rest apologised due to time constraints. This left us with only nine teachers whose responses are illustrated throughout the study. It should be noted that interviews are not that customary in the Saudi context and, with such an instrument, females are less comfortable to open up and provide detailed responses. This explains the low participation of females.

Confidentiality for questionnaire respondents and interviewees was assured as names of teachers have been removed. To insure confidentiality, none of the responses, whether in the questionnaires or interviews, were reported back to the school principal or to the CPD leader.

Findings

In analysing the data, we were primarily interested in identifying themes and patterns that could emerge rather than isolated variables. We used a thematic analysis which allowed us to group the large number of variables in ways that were consistent with the literature and count important about the data that capture findings that relate to the research questions. We used the thematic analysis that Braun & Clarke (2006) summed up which ' …involves the searching across a data set—be that a number of interviews or focus groups, or a range of texts—to find repeated patterns of meaning' (p. 86). The analysis required moving back and forth to extract the coding of the identified themes in what is known as a 'recursive process'. The main guide to our thematic analysis followed what Braun & Clarke (2006) stated as the six phases of analysis that are as follows: familiarising ourselves with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes and, finally, producing the report. It should be noted that the first author was responsible for the data analysis while the second author reviewed and discussed the coding and helped name the themes. Data from the teacher responses to both the questionnaires and interviews were grouped under the identified themes in terms of triangulating the findings. Triangulation in this study was by multiple methods to cross-reference the collected data that enrich the validity (Silverman, 2000).

In presenting the findings, a specific coding was allocated according to the source of the data. Findings from the open-ended questionnaire were represented by stating the gender of the respondent, the specific area of discipline and then teachers' years of experience. As for data from the interview questions, these were coded according to the first letter of the respondent's name in addition to gender, specific area of discipline and years of experience. When teachers shared the same, a second letter in their name was added to distinguish among them. An abbreviation was given at the end of each quote, as follows: opened-ended data were given QE, while quotes from the interviews were IQ. The thematic analysis of the data resulted in the identification of two main themes:

1. Identifying a typology of 'how' CPD could be presented in terms of the types of activities that teachers prefer to have according to their previous experiences; this answers research question 1.
2. Identifying a typology of 'what' content could be presented in CPD activities based on teachers' needs; this answers research question 2.

Theme 1: Typology of the CPD Activities

1. Most preferred types of activities

The majority of responses mentioned a variety of CPD activities that have been used in different programmes when responding to the following question: 'What were the training activities used in CPD programmes that you prefer?' Two main themes were identified according to teachers' experiences in relation to how the content was presented. These themes were identified by their nature and role of the participants into 'transmissive' and 'constructivist' themes. Responses from the open-ended questionnaire and interviews were analysed; findings from the questionnaire showed that 99 were constructivist in nature and 31 were transmissive. The analysis indicated that there were contextual and pedagogical perspectives underpinning teachers' preferences.

1.1 Constructivist CPD activities as the most preferred type of activity

Analysis from teachers' responses to the open-ended questionnaire illustrated that they prefer activities that are constructivist in nature and which require participants' active involvement. This shows that teachers seem to benefit the most in programmes where they are positively involved and engaged rather than passive recipients of knowledge. It also shows that they are aware that constructivist

practices are recommended as a learning approach. 'Cooperative learning' as an activity for CPD represented the most preferred activity among respondents in this particular type. Table 1 shows the analysis of responses to each type of activity.

Forty responses from a total of 99 in the open-ended questionnaire selected 'cooperative learning' as the best strategy used in CPD programmes.

> Cooperative learning was the best because it consists of discussion and exchange of experiences. Through it, there is a high sense of cooperation and fun among the participants. (Female, biology teacher, 15 years of experience, OE).

Data from the interviews aligned with those from the open-ended questions. Examples of teachers' comments are below. Four teachers (R, AB, M and AM) clearly stated that they preferred cooperative learning as a strategy to be used in CPD programmes. Reasons behind this selection varied. Teacher 'R' stated its benefit in overcoming any difficulty and the chance for revising information. Teacher 'AB' identified that it is a means to cater to individual differences. Teacher 'M' commented that it helps form an active and energetic class, while teacher 'AM' stated that social intelligence is a main outcome of cooperative activities.

The number of responses from the open-ended questionnaire related to 'cooperative learning' was 40. This was substantially more than their responses to other types of activities such as 'hands-on activities' (only 11 responses) indicating 'cooperative learning' as their preferred type of activity. The activities with

TABLE 1

Analysis of teacher's responses of the most preferred constructivist types of activities, $N=99$

Type of activity	*Frequency of responses*
Cooperative learning	40
Hands-on application	11
Constructivist	9
Exercises	7
Inquiry-based learning	5
Discovery learning	3
Problem solving	2
Concept mapping	2
Six hats	1
Projects	1

the lowest responses in the constructivist theme were problem solving, modelling, projects and activities that required the use of ICT such as self-learning and distance learning strategies. Examples of teacher quotations indicating the above preferred types are as follows:

> Constructivism, brainstorming, cooperative learning and inquiry (Female, physics secondary teacher, 13 years of experience, OE).
> Inquiry as it makes the trainee at the centre of the programmes and he/she has to conclude the objectives and the content at hand. (Male, physics secondary teacher, 5 years of experience, OE).
> Inquiry, and cooperative learning and projects. (Female, chemistry secondary teacher, 3 years of experience, OE).

1.2 Transmissive CPD activities as the most preferred type of activity

A total number of 31 teachers from the open-ended questionnaire selected transmissive activities as their most preferred type of CPD activities according to their experiences in previous programmes. From them, the most frequent type was 'workshops', followed by 'presentations' then 'lectures' (16, 12, 3, respectively). Data analysis from the interviews reported on teachers' experiences in previous CPD programmes. Teacher 'F' stated the activities that are most followed in CPD programmes and criticised such programmes as in the following quotation:

> Most of the programmes that I attended were intuitive efforts from the trainer. So the trainer is the one who designs and develops the material then gets approval from the training centres. The strategy used is mainly PowerPoint presentations with elaborations from the trainer to the trainees when they need further explanations. In general these programmes can be easily studied at home as they are just presentations. Some trainers interact with the trainees while others do not. In some programmes there are workshops, but they are usually not that effective as there is always limited time. (T/F, male, geology teacher, 9 years of experience, IQ).

2. Least preferred types of activities

The majority of responses mentioned a variety of CPD activities that have been used in different programmes when responding to the following question: "What were the training activities used in CPD programmes that you least prefer?" Responses from the open-ended questionnaire and interviews were analysed; 16 were constructivist in nature, and 40 were transmissive according to responses from the open-ended questionnaire.

2.1. Constructivist CPD activities as the least preferred type of activity

Sixteen responses named constructivist activities in their least preferred type of activities (Table 2).

By looking at the responses in the table above, teachers stated that 'role play' was the type of activity that they would least prefer to have in CPD programmes. 'Critical thinking' and 'brainstorming' came second in rank according to the frequency of responses, while 'inquiry-based, constructivist learning', cooperative learning and the six hats came equally in the fourth rank. By analysing the interview data, there was no credible explanation in teachers' responses clarifying or even justifying why they gave such response.

2.2. Transmissive CPD activities as the least preferred type of activity

Forty responses from the open-ended questionnaire were given when teachers were asked to assert their least preferred type of activity. Analyses of teachers' selections show that 37 responses identified 'lectures' as the least preferred type while three responses identified 'presentation' as their selected least preferred type of activity. Quotations from a teacher's response that illustrates the traditional transmissive activities:

> In general lectures are not useful, as they do not provide any explanation of how to apply the new ideas in science lessons. I have seen presentations where the trainer talks and talks or sometimes reads from the slides and there is no interaction with the participants. (Male, chemistry teacher, 10 years of experience, OE).

Throughout the interview data, it seemed that there was a high level of agreement among the teachers that 'lecturing' is the least successful strategy in CPD programmes. The main reason behind this selection refers to several issues. Teacher 'R' stated that its holistic view of learners and negligence of individual differences were her personal view of this

TABLE 2

Analysis of teacher's responses of constructivist activities as their least preferred type, $N=16$

Type of activity	*Frequency of responses*
Role play	4
Critical thinking	3
Brainstorming	3
Inquiry-based learning	2
Constructivist learning	2
Cooperative learning	1
Six hats	1

selection, while Teacher 'A' stated that it is boring and perceived the disadvantage of lecturing to be its main reliance on learners' verbal intelligence, ignoring the fact that not everyone excels at this style of learning, referring to herself in this case as in the following quote:

> Lecturing is the worst as there is no practical application and it destroys differences in participants' points of view. If there is no other strategy than lecturing, then is has to be with presentations to help grab participants' attention and focus. I can see that lecturing is the worst type because it relies on verbal intelligence and I am not a verbal learner, which makes me distracted and I only manage to understand the final points. (T/A, female, biology teacher, 8 years of experience, IQ).

Theme 2: Typology of Content According to Teachers' Needs

In the open-ended questionnaire, teachers were given the opportunity to voice their selection of the topics they require to be covered in future CPD programmes based on their needs. A total of 167 responses were analysed for this question, but before we introduce the results and main findings, it is important to note that teachers reported that they were not consulted in selecting topics to be included in CPD programmes; the analysis of their responses stressed the practice of presenting 'pre-planned' programmes that do not fit the teachers' professional needs. The fact that teachers' voices are not heard in planning CPD programmes made some of the comments express regret for this situation and imposed a feeling of frustration and hope for future improvement. Yet, teachers wanted to take part in planning the CPD programmes to improve their classroom practices. Findings from teachers' interviews showed that eight of the nine teachers stated that they were not consulted at all in regard to suggesting or selecting the content of the CPD programmes.

> No, I was not consulted, and now the CPD programmes are consistent all over the kingdom, with a certain title and fixed pre-set content, which could be found on the Internet and accessed. (T/R, female, chemistry teacher, 8 years of experience, IQ).

Nonetheless, teachers' responses to the preferred content of the activities were categorised into four main themes according to the number of responses in a descending order: pedagogical, scientific, personal skills and ICT.

1. Pedagogical knowledge

This theme referred to all aspects that relate to classroom teaching, including teaching methodologies, classroom management, assess-

ment, teaching resources, accommodating for individual differences and increasing students' motivation. The number of responses relevant to this theme was 74 from the open-ended questionnaire, which does not represent the total number of teachers filling in the questionnaire, as it is possible to find one teacher giving more than one response in more than one category, while other teachers had blank responses. The following subthemes are those that had the highest frequencies, despite teacher gender, district, years of experience or even speciality: deepening pedagogical content knowledge, reformed curricula and classroom management. Subthemes with limited numbers of responses were pictorial readiness, time management, how to train other teachers and project management. Table 3 illustrates results of the analysis.

1.1. Deepening pedagogical content knowledge

This subtheme entails knowledge of common conceptions, misconceptions and difficulties that students encounter when learning science. It also includes knowledge of specific teaching strategies, analogies and metaphors that can be used to address students' needs in particular classroom situations.

> [I want] all pedagogical knowledge that will increase my knowledge and help me in my teaching to my students. This needs to include all aspects related to teaching starting from the introduction until assessing student learning. (Female, physics teacher, 13 years of experience, OE).

1.2. Responsive to the reform in science curricula

Teachers wanted to attend CPD with content focused on the reformed science curricula. It was a surprise that even experienced

TABLE 3

Analysis of teachers' responses to the focus of the CPD content/pedagogical knowledge, $N=74$

The focus of the CPD content/pedagogical knowledge	*Frequency of responses*
Deepening pedagogical content knowledge	30
Reformed curricula	20
Classroom management	8
Assessment	5
Individual difference	5
Teaching resources	4
Everything that relates to pedagogy	1
Pupil consultation	1

teachers wanted the CPD to focus on giving them guidance to teach the curricula.

> [I want to] attend programmes that are relevant to science curricula (biology, physics and chemistry) and the educational processes. (Female, chemistry teacher, 19 years of experience, OE).

1.3. Classroom management

Classroom management referred to all activities carried out by the teacher to ensure students' discipline and order in the class

> Programmes that are directed to how to deal with students in the class. In other words the art of dealing with students and classroom management. (Male, chemistry teacher, 4 years of experience, OE).

1.4. Assessment

Few teachers suggested that CPD programmes should focus on 'assessment'. It was a surprise that only five teachers mentioned it. This seems to give an indication that teachers are experienced in developing and applying various types of assessment.

> In the educational field we need programmes that are directed to assessment tools that are effective and realistic and show how to make use of the results. (Female, physics teacher, 11 years of experience, OE).

Only one teacher specifically asked for programmes that address constructivist assessment tools: "Highlight on constructivist assessment in detail and how to apply it to the reformed curriculum." (Female, biology teacher, 11 years of experience, OE).

1.5. Accommodating students' individual differences

A limited number of teachers were concerned about pedagogies that deal with differentiation. This addresses differences in terms of achievement levels, learning styles and accommodating in general for individual differences.

> Any programme that helps recognise student's characteristics and how to deal with their variations. (Female, chemistry teacher, 10 years of experience, OE).

2. Content knowledge

This theme relates to all aspects of the scientific knowledge content and its practical side in terms of dealing with experiments or using tools and equipment. A total of 56 responses from the open-ended questionnaire represented this theme and the three subthemes

of which it consists. These were 'deepening subject content knowledge=32', 'practical skills=22' and 'cultural issues related to science=2'.

2.1. Deepening subject content knowledge

This issue was the most frequently found need among teachers as it is not surprising to have the majority of responses from teachers in this subtheme specially since they, as secondary-stage teachers, have to deal with advanced levels of chemistry, physics and biology. It could also be that the reformed curricula included topics different from those in which teachers are knowledgeable. Teachers on some occasions suggested that CPD programmes include certain topics that relate to the content knowledge they teach.

> Training on the reformed science curricula (biology-physics-chemistry) and how to attract students' attention towards such content. This could be through workshops [in science] that are directed to our specific scientific background that are presented in a simple and useful way (Female, chemistry teacher, 18 years of experience, OE).

This raises questions of how appropriate is teachers' content knowledge (CK) for them to teach at the secondary level. It also relates to their educational programmes as pre-service teachers, in addition to the extent that school curricula are frequently updated and reformed. But, most importantly, this raises questions about the influence of the curricula on teachers' perspectives and expectations of CPD programmes. In addition, this reflects to what extent teachers are dependent on the CPD in developing their subject content knowledge and the extent that teachers are confident and secure about their content knowledge.

2.2. Practical skills

Other responses included reference to how science works and how to carry out experiments and activities whether in class or in science labs. This reflects science teachers' views of the nature of science. How science works also relates to all the skills needed to use tools and equipment. This need seems to link to the advanced level secondary-stage teachers teach and requirements of the reformed curricula.

> The content should include hands-on experiences of all the practical experiments that are included in the reformed curriculum. And this is why programmes should help teachers' develop their practical skills effectively (Male, physics teacher, 4 years of experience, OE).

In the interview data, one teacher highlighted a point related to lab safety in her comment:

> Skills for carrying out experiments and how to deal with any hazards in the lab and also alternative experiments. (T/M, male, chemistry teacher, 19 years of experience, IQ).

2.3. Cultural issues related to science education

Teachers emphasised the necessity of CPD programmes to tackle pedagogically the relationship between religion and science education

> All educational and scientific programmes like this are considered a religious request that we should learn and develop ourselves even if we have to travel to China. It is therefore of extreme importance to link science education to the scientific wonders that are documented and cited in the Holy Qur'an. (Female, biology teacher, 14 years of experience, OE).

Interview data also emphasised this link. Teachers R and A both shared their need for training that tackles pedagogically the relationship between religion and science education, in addition to having other additional individual educational needs as well. One of them mentioned:

> We have problems with projects, students, parents and linking science with religion we need to learn how to tackle pedagogically such relationship and how to link science to everyday life, (T/A, female, biology teacher, 8 years of experience, IQ).

3. Technological pedagogical content knowledge (TPCK)

Twenty-two responses from the open-ended questionnaire identified that they needed CPD programmes that develop their technological knowledge and show them how to use technology in teaching. This would include the use of general technological tools that any discipline would benefit from such as the Internet or virtual labs. It would also include tools specific to science such as digital microscopes.

> I suggest that the content include topics in the use of ICT and the use of technological advancements. We really need to know more about technology not just some basic steps in using equipment, but using it technologically correctly and in a way that helps in students' learning. It would be really great to learn how to use technological advancements in teaching such as the virtual lab or even how to produce films and use advanced software such as Flash that could really help in our teaching and [so that] students will understand science even better. (Female, biology teacher, 25 years of experience, OE).

The main concern of teacher 'SA', in the interview data, was how to use educational technology in teaching. This could reflect not only his

awareness of the benefits of ICT and students' preferred styles of learning but also the issue of the school's lack of facilities:

CPD programmes in educational technology and how to use it in class. But there is a problem as even if I attend such programmes, the school is not equipped with such facilities and this is enough to stop all efforts. (T/SA, male, chemistry teacher, 19 years of experience, IQ).

4. Professional skills

Teachers stressed the need for CPD programmes that develop their professional autonomy, e.g. leadership, action research and self-development. A total number of 15 responses were categorised in this theme. Table 4 illustrates details of the responses to the open-ended questions.

4.1. Thinking skills

Seven responses indicated that they prefer to attend CPD programmes that include content which aims to develop thinking skills either of themselves and/or their students; creative and critical thinking were at the core of their selections.

I want to attend programmes that could help me deal with the students to develop their creativity skills. This is why I need to have such skills as well as you cannot teach your students what you do not have. So I would surely be happy to have programmes that could develop my own critical and creative thinking skills. (Male, physics teacher, 12 years of experience, OE).

4.2. Self-development and learning how to learn

Five responses indicated that they preferred to attend CPD programmes that aim to develop their skills of 'learning how to learn' and can therefore impact their self-development. The following quotes are examples from these responses:

Everything that can help in changing oneself for the better in terms of self-development. (Female, biology teacher, 18 years of experience, OE).

TABLE 4

Analysis of teachers' responses to the focus of the CPD content/professional skills, $N=15$

The focus of the CPD content/professional skills	*Frequency of responses*
Teaching skills	7
Self-development/learning how to learn	2
Self-efficacy	3
Teacher as researcher	3

4.3. Teacher as a researcher

A limited number of responses, three responses in total, expressed a need to get training on action research in order to be able to research their practices, but mainly to improve them further.

> Programmes that concentrate on individual and group development and that support constant research on how to improve students' educational levels. (Female, biology teacher, 5 years of experience, OE).

Discussion

This study presented findings in relation to two main aspects of CPD activities. Data were collected using tools that gave science teachers a voice to echo their preferences and needs. The study proposed a typology of 'what' teachers want to learn in terms of CPD content and 'how' they want the content to be presented. Each of these points was then categorised in terms of themes and subthemes that helped form the final typology of CPD activities that were contextual and illustrated pedagogical perspectives underpinning teachers' preferences.

Teachers' Preferred Ways of Professional Learning

The findings reported in this study allow us to draw some conclusions about teacher learning in professional development. Concerning our first research question, we can conclude that the general pattern from the data provides us with a picture of what science teachers need in their CPD programmes in terms of pedagogical, professional and science content. Each of these themes helped portray needs that are considered the basis for 'bottom-up' professional development programmes where teachers have a say in what they want to know more about (Galanouli, 2010; Schreurs & De Laat, 2012). It was clear that knowing more about how to teach in terms of PCK and what to teach in terms of CK was at the core of teachers' needs. This is in line with what Dillon et al. (2000) reported from their UK study that teachers had strong views about the CPD they received and what they felt was wanted as this could be seen as the driving force for developing CPD programmes that target teachers' needs.

Findings revealed that teachers with constructivist orientations prefer activities where they are engaged and positively involved, rather than activities where they are passive and 'absorptionist'. According to Lieberman & Pointer Mace (2008), teachers' active physical, cognitive

and emotional engagements are what make the qualities of effective PD. Nonetheless, Boyle, Lamprianou & Boyle (2005) acknowledged that traditional professional development can foster teacher awareness and deepen their knowledge and skills, yet they seem insufficient to foster major changes on 'what' and 'how' teachers teach. Nonetheless, Quick, Holtzman & Chaney (2009) seemed to acknowledge the matter of time spent during the CPD activity rather than the type of activity itself. This finding echoes what Hargreaves (2003) stresses that the need to differentiate activities as 'one-size fits all' may not be the optimum. Science teachers in the Saudi context wanted to be engaged as learners and seemed to prefer to experience activities and instructional strategies that could be used with their own students. Teachers from both genders and with various years of experience were in favour of cooperative learning activities where they learn in a social context and exchange experiences. This view of socio-constructivist learning has been built on the idea of a community of practice described by Lave & Wenger (1991). There could be other lenses for looking at cooperative learning; this is mainly what is mentioned from a meta-analysis study (Cordingley, Bell, Thomason & Firth, 2005) which shows that cooperative and collaborative CPD are more likely to be capable of supporting successful outcomes for teachers and student learning, as teachers share evidence about their practices and start trying out new approaches. The findings revealed in this study in general seem to reflect how teachers learn. Concurrently and as part of the constructivist learning process in the CPD activities, teachers are asked to reflect on these learning experiences. The process of making sense of new experiences will facilitate the shift from the transmissive view of learning and teaching to the constructivist view. The study also argues that collaborative learning activities, as core features of CPD programmes that allow for discourse and social construction of knowledge, are preferred by science teachers. Such activities encourage teachers' discussion and exchange of experiences on issues of mutual concern in the science classroom.

Teachers' Views of the CPD Content

The content that teachers preferred to focus on through CPD programmes was pedagogical content: science subject, ICT and professional content (in a descending order). This aligns with findings from other studies that found the top two areas of focus in CPD are on both subject area content and how it is taught (Lieberman & Pointer Mace, 2008; Porter, Garet, Desimone & Birman, 2003). This finding indicates that teachers were not

satisfied with their current teaching practices and therefore need to be updated with the state of the art in terms of how to teach or what Shulman termed pedagogical content knowledge (PCK). The responses indicated that teachers were asking, in general, for constructivist approaches to teaching. Other teachers identified specific methodologies yet framed within constructivism. It seems that their perspective of a learning context is that the learner is at the core. This finding concurs with previous studies that focus on CPD programmes on teaching methodologies (Van Driel & Berry, 2012). Chval et al. (2008) listed teachers' professional development topics where they identified that 'instructional strategies' were second on the list in terms of the highest frequency. In general, if teachers do not find the content that meets their needs and addresses them clearly, then CPD experiences might not attract as many teachers to attend. Moreover, to help foster positive attitudes towards constructivism, teachers should be involved in positive experiences that show how they can implement constructivism in their classrooms (Bandura, 1986).

Science Curriculum Reform Drives the CPD Agenda

The new science curricula in Saudi Arabia brought pedagogical challenges to the teachers. These new curricula focus on inquiry, debate, dialogue and collaborative learning. This explains the teachers' demands for the CPD to focus on these pedagogies. Teachers' reflections on their professional needs raise questions about not just the quality of the CPD they have participated in but also the quality of the reform process of the science curricula that ignored the teachers' views, beliefs, learning and pedagogical skills in relation to the ideology of these new curricula. This finding links to what Rafea & Aloaisheq (2010) argued in their study that seems to assure that science education reform in Saudi Arabia increases the discrepancy between what teachers know and practice, and the requirements for teaching new science curricula. The study concluded that the new science curricula seem to introduce many new issues for science teachers and that teachers are aware of their need for such new issues (i.e. innovative pedagogical skills).

Conclusion and Implications

The study advocates a socio-constructivist perspective towards science teacher professional development. In this sense, the study argues that

teacher learning cannot be separated from action. As is strongly indicated by the teachers in this study, pedagogical knowledge is not thought of as a received, static entity that is separate from the individual (Richardson, 1997). Teachers in this study strongly expressed a demand that the CPD must respond to changes in the science curricula and to their school contexts and social contexts. One way to respond to these contexts and changes is to provide teachers with learning mechanisms that they can use, not to be adaptive to these changes but to constructively interact with their contexts. Therefore, the CPD activities need to promote a space for discussion among the teachers regarding their own contexts and to reflect on their own practices. Within this framework, the development of an individual relies on social interactions. Within this social interaction, cultural meanings are shared within the group and internalised by the individual (Richardson, 1997). In this sense, Kimble, Yager & Yager (2006) argue for establishing a consistent active involvement in constructivist-based CPD programmes in order to promote change that leads to prolonged implementation of constructivist-based practices in the classroom. In both cases, there is a valid argument that links to teachers' learning and the role they adopt, whether active or passive, while involved in CPD programmes. It also links to the concept of 'change' and the structure of the CPD programmes that aim to enhance this.

Other arguments extend to the impact of CPD learning and change on teacher classroom practices. In this context, Cordingley et al. (2005) identified that change in teaching practice comes as a result of collaborative rather than individual CPD, while Dalgarno & Colgan (2007) found changes in practice when teachers were allowed to test ideas and take risks during CPD. The findings of this study concur with what Goos (2008) stated, that teacher learning draws on discourse and practice perspectives, and with the views of CPD programmes according to Bransford et al. (2000).

In conclusion, the suggested typology presented in this study and which links the research questions together helps form a framework in regard to future PD and the theory behind it. We argue that viewing CPD activities within the proposed typology gives them value and coherence as the identified themes underpin the socio-constructivist theory at their core. In order to develop effective science teacher education programmes, the main implication for CPD designers and providers is that future CDP programmes should be framed by the socio-constructivist theory where teachers' voices and needs are catered for in terms of pedagogical,

scientific and technological content and where teachers' preferred types of activities in CPD programmes are taken into account.

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Appendix

The following questions were addressed in the open-ended questionnaire:

- Describe what the most preferable training activities used in CPD programmes are.
- Describe what the least preferable training activities used in CPD programmes are.
- Were you consulted about specifying the content and topics to be included in the CPD programmes that you participated in or CPD programmes you are about to participate in (yes, no)? Explain and state examples.
- If you were given the opportunity to select the topics and content of future CPD programmes that you would like to attend to address your needs, state examples of what that would be.
- Would you accept to participate in an interview to elaborate further on your responses to this questionnaire?

Examples of the interview questions:

- Were you consulted on the content of the programmes?
- What are the activities that were used in the CPD programmes, and were they all effective? Please elaborate.
- In what way do you think is the best activity to present CPD content?
- Describe the best activities used in CPD programmes and elaborate why you think that it was the best.
- Describe the worst activities used in CPD programmes and elaborate why you think that it was worst.
- What are the educational aspects that you need CPD programmes to address in the future?

- What are the scientific or academic aspects that you need CPD programmes to address in the future?

REFERENCES

Aldahmash, A. & Alshamrani, S. (2012). The nature of Saudi science teacher practices of the scientific inquiry: Supervisors' perspectives. *Journal of Educational Sciences, 13*, 439–462. Bahrain (In Arabic).

Alshamrani, S. (2012). Priorities of research in science education in Saudi Arabia. *Journal of Educational Sciences and Islamic Studies, Saudi Arabia, 24*(1), 199–128.

Alshayea, F. & Abdulhameed, A. (2011). Mathematics and natural sciences project: Hopes and ambitions. Paper presented at the *15th Annual conference for the Association of Science Education*, Egypt (In Arabic).

American Association for the Advancement of Science (AAAS). (1993). *Benchmarks for science literacy*. Washington, D.C.: American Association for the Advancement of Science (AAAS).

Appleton, K., Ginns, I. & Watters, J. (2000). The development of pre-service elementary science teacher education in Australia. In S. Abel (Ed.), *Science teacher education: An international perspective* (pp. 9–29). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Austin, Z., Marini, A. & Glover, N. (2005). Continuous professional development: A qualitative study of pharmacists' attitudes, behaviors, and preferences in Orientario Canada. *Journal of Pharmaceutical Education, 69*(1), 25–33.

Avalos, B. (2011). Teacher professional development in teaching and teacher education over ten years. *Teaching and Teacher Education, 27*, 10–20.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher, 33*(8), 3–15.

Boyle, B., Lamprianou & Boyle (2005). A longitudinal study of teacher change: What makes professional development effective? Report of the second year of the study. *School Effectiveness and School Improvement, 16*(1), 1–17.

Bransford, J., Brown, A. & Cocking, R. (2000). *How people learn*. Washington, DC: National Academy Press.

Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101.

Chval, K., Abell, S., Enrique, P., Musikul, K. & Ritza, G. (2008). Science and mathematics teachers' experiences, needs and expectations regarding professional development. *Eurasia Journal of Mathematics, Science & Technology Education, 4*(1), 31–43.

Clarke, D. & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teacher and Teacher Education, 18*(8), 947–967.

Cordingley, P., Bell, M., Thomason, S. & Firth, A. (2005). *The impact of collaborative continuing professional development (CPD) on classroom teaching and learning. Review: How do collaborative and sustained CPD and sustained but not collaborative CPD affect teaching and learning?* London: EPPI-Centre.

Crawford, B. (2007). Learning to teach science as inquiry in the rough and tumble of practice. *Journal of Research in Science Teaching, 44*(4), 613–642.

Dalgarno, N. & Colgan, L. (2007). Supporting novice elementary mathematics teachers' induction in professional communities and providing innovative forms of pedagogical content knowledge development through information and communication technology. *Teaching and Teacher Education, 23*(7), 1051–1065.

Darling-Hammond, L. (1997). *The right to learn: A blueprint for creating schools that work*. San Francisco: Jossey-Bass.

Desimone, L., Porter, A., Garet, M., Yoon, K. & Birman, B. (2002). Effects of professional development on teachers' instruction: Results from a three-year longitudinal study. *Educational Evaluation and Policy Analysis, 242*, 81–112.

Dillon, J., Osborne, J., Fairbrother, R. & Kurina, L. (2000). *A study into the professional views and needs of science teachers in primary and secondary schools in England*. London: Council for Science and Technology.

Galanouli, D. (2010). School-based professional development: A report for the general teaching council in Northern Ireland. Retrieved May 21, 2013, from: http://dera.ioe.ac.uk/11060/1/School_Based_Report_April2010.pdf.

Garet, M., Porter, A., Desimone, L., Birman, B. & Yoon, K. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*(4), 915–945.

Goos, M. (2008). *Towards a sociocultural framework for understanding the work of mathematics teacher*. Retrieved April 16, 2013, from: http://www.merga.net.au/documents/RP252008.pdf.

Hargreaves, A. (2003). *Teaching in the knowledge society: Education in the age of insecurity*. Buckingham: Open University.

Jones, M. & Eick, C. (2007). Implementing inquiry kit curriculum: Obstacles, adaptations, and practical knowledge development in two middle school science teachers. *Science Education, 91*, 492–513.

Kennedy, A. (2005). Models of continuing professional development: A framework for analysis. *Journal of In-service Education, 31*(2), 235–250.

Kimble, L., Yager, R. & Yager, S. (2006). Success of a professional-development model in assisting teachers to change their teaching to match the more emphasis conditions urged in the National Science Education Standards. *Journal of Science Teacher Education, 17*(3), 309–322.

Kreber, C. (2006). Developing the scholarship of teaching through transformative learning. *Journal of Scholarship of Teaching and Learning, 6*(1), 88–109.

Lave, J. & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Lieberman, A. & Pointer Mace, D. (2008). Teacher learning: The key to education reform. *Journal of Teacher Education, 59*(3), 226–234.

Loucks-Horsley, S., Love, N., Stiles, K., Mundry, S. & Hewson, P. (2003). *Designing professional development for teachers of science and mathematics* (2nd ed.). Thousand Oaks, CA: Corwin Press.

Mansour, N., Alshamrani, S., Aldahmash, A., & Alqudah, B. (2013). Saudi Arabian science teachers and supervisors' views of professional development needs. *Eurasian Journal of Educational Research, 51*, 1–27.

Mansour, N., EL-Deghaidy, H., Alshmrani, S., & Aldahmash, A. (2014). Rethinking the theory and practice of continuing professional development: Science teachers' perspectives. Research in Science Education. doi: 10.1007/s11165-014-9409-y.

National Council for Accreditation of Teacher Education, NCATE. (2001). *Standards for professional development schools: The standard of excellence in teacher preparation*. Retrieved April 16, 2013, from: http://www.ncate.org/LinkClick.aspx?fileticket=P2KEH2wR4Xs%3d&tabid=107.

National Council for Accreditation of Teacher Education, NCATE. (2002). *Professional standards for the accreditation of schools, colleges, and departments of education*. Washington, D.C.: University of Virginia.

National Research Council, NRC. (1996). *National science education standards*. Washington, DC: National Academy Press.

Peers, C., Diezmann, C. & Watters, J. (2003). Supports and concerns for teacher professional growth during the implementation of a science curriculum innovation. *Research in Science Education, 33*, 89–110.

Pharr, W., Starr, C. & Edwards, C. (2009). Paired professional development: A methodology for continued professional development in computer science. *Proceeding of the 2009 ACM SIGSE annual conference on innovation and technology in computer science education*. In ITICSE, 218 – 222.

Porter, A., Garet, M., Desimone, L. & Birman, B. (2003). Providing effective professional development: Lessons from the Eisenhower program. *Science Educator, 12*(1), 23–40.

Putnam, R. & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher, 29*(1), 4–15.

Quick, H., Holtzman, D. & Chaney, K. (2009). Professional development and instructional practice: Conceptions and evidence of effectiveness. *Journal of Education for Students Placed at Risk, 14*(1), 45–71.

Rafea, A. & Aloaisheq, N. (2010). The project of mathematics and natural sciences: translated and adapted curricula. A paper presented at the *"The Project of Mathematics and Natural Sciences: translated and adapted curricula"*. King Saud University, Riyadh, Saudi Arabia.

Richardson, V. (1997). Constructivist teaching and teacher education: Theory and practice. In V. Richardson (Ed.), *Constructivist teacher education: Building new understandings* (pp. 3–14). Washington, DC: Falmer Press.

Robinson, M. & McMillan, W. (2006). Who teaches the teachers? Identity, discourse and policy in teacher education. *Teaching and Teacher Education, 22*, 327–336.

Robson, J. (2006). *Teacher professionalism in further and higher education: Changes to culture and practice*. Abingdon: Routledge.

Schreurs, B. & De Laat, M. (2012). Work-based networked learning: A bottom-up approach to stimulate the professional development of teachers. *Proceedings of the 8th International conference on Networked Learning 2012*.

Silverman, D. (2000). *Doing qualitative research: A practical handbook*. London: Sage.

Sleegers, P., Bolhuis, S. & Geijsel, F. (2005). School improvement within a knowledge economy: Fostering professional learning from a multidimensional perspective. In N. Bascia, A. Cumming, A. Datnow, K. Leithwood & D. Livingstone (Eds.), *International handbook of educational policy* (pp. 527–543). Dordrecht: Kluwer Academic Publishers.

Van Driel, J. & Berry, A. (2012). Teacher professional development focusing on pedagogical content knowledge. *Educational Researcher, 41*(1), 26–28.
Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological process.* Harvard University Press.
Weiss, I., Banilower, E., McMahon, K. & Smith, P. (2001). *Report of the 2000 survey of science and mathematics education*. Chapel Hill, NC: Horizon Research.
Welmond, M. (2002). Globalization viewed from the periphery: The dynamics of teacher identity in the Republic of Benin. *Comparative Education Review, 46*(1), 37–65.

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