A framework for designing effective professional development: Science teachers'perspectives in a context of reform

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This paper explores science teachers' experiences, views, and preferences of what constitutes effective teacher professional development. The research method utilised both quantitative and qualitative analyses. The former was used with responses from closed-ended questions while responses to an open-ended question were analysed qualitatively. The questionnaire was administrated to science teachers in Saudi Arabia of both genders with a variety of teaching experiences, science specialisms and to those teaching in primary, middle and secondary stage schools. The findings indicate that teachers have concerns about continuing professional development (CPD) programmes offered to them. Teachers' description of CPD showed that they were passive recipients of a pre-packed programme paving the way to how they form their professional identity. Teachers reflected on the aspects that can lead to effective CPD. Drawing on the findings, this paper presents a framework for effective CPD for science teachers where teachers are collaborative, proactive as leaders of reform and with positive professional identities in a context of reform.

Keywords: continuing professional development CPD, in-service science teachers, reform

INTRODUCTION

In a teaching career, teachers are expected to be equipped with teaching competencies that need to be upgraded according to pedagogical pressing needs that reflect contemporary teaching strategies and advancements in subject

knowledge (Donaldson, 2011). Day (1997) and Mansour, EL-Deghaidy, Alshamrani & Aldahmash, (2014) argue that there is a gap between theory and practice in relation to teacher professional development as a means to upgrading needs. Day and Mansour et al. moreover asserted the significance of addressing the relationship between theories and practices. To do so, teachers' perspectives need to be taken seriously. It has been noted that teachers may express their dissatisfaction with the professional development opportunities they receive. Previous studies have documented examples of teachers' dissatisfaction. They have also shown that teachers insist that the most effective development programmes, according to their experiences, are those which are self-initiated (National Research Council, 2007). Examples of self-initiated activities within the context of CPD are peer observation, professional discussion and even informal networking (Day, 1999; Goodall, Day, Lindsay, Muijs & Harris, 2005). Moreover, Bezzina (2003) claimed that CPD which takes place outside of schools by its nature decontextualises the learning needs of teachers. Bezzina therefore suggests that more in-house, networking or clustering need to be organised and supported to satisfy teachers' needs for attending

State of the literature

- Teacher learning is constructed and re-constructed among the beneficiaries of CPD.
- CPD plays a key role in implementing a new curriculum or an innovation in schools.
- Teachers need to be provided with different ways to change their practices and get support during the actual change process in their own classrooms.

Contribution of this paper to the literature

- The use of simultaneous reform happening both bottom-up and top-down requires identity building to help teachers change the way they view themselves and their roles in the educational system.
- Having the CPD material presented using a 'one size fits all' may not be that helpful as a means to facilitating reform and change.
- The anticipated framework of an effective CPD is therefore one that empowers teachers to lead reform initiatives, teachers who are proactive in a community of change to suggest where reform is needed rather than become superficial followers of a top-down reform.

effective professional development programmes. Stoll, Bolam, McMahon, Wallace and Thomas (2006) perceive that CPD is all about workplace learning. Through workplace learning there is an appreciation of learning that is context-dependent, whether it is formal or informal (Hagar, 2004) as long as teacher learning is constructed and re-constructed among the beneficiaries of CPD. Loucks-Horsley, Love, Stiles, Mundry and Hewson (2003) outlined principles of effective professional development which include:

> having a clear image of effective classroom practices, providing opportunities for teachers to build their content and pedagogical content knowledge, providing time for teachers to reflect on their practice, immersing teachers in research based learning approaches that they can use with their students, forming collaborative communities, and focusing on student learning data. (p. 44)

In the same vein Thompson and Zeuli (1999) argued that effective professional development must create 'cognitive dissonance' in participating teachers in order to change their pre-existing beliefs and practices. Thompson and Zeuli argued that teachers must be given time to work through this change with discussions, readings, writings, and other activities that make their beliefs more concrete and revisable. Teachers also need to be provided with different ways to change their practice and find support during the actual change process in their own classrooms. With these findings, there is an urgent call and challenge for policy makers to find means to understand what teachers want and what will teachers personally find meaningful in order to design effective CPD programmes accordingly. Research shows the significance of teacher engagement in developing their pedagogical knowledge. From the findings stated above, the next step is the design of CPD programmes that respond to teachers' needs with a greater emphasis on the teachers' role and involvement in the planning of these programmes which result in helping teachers

form their professional identities. Research has highlighted the importance of identity in teachers' lives as it is not something fixed or static. Day et al. (as cited in Webb, 2013, p.32) stated that it is 'an amalgam of personal biography, culture, social influence and institutional values which may change accordingly to role and circumstance'.

According to Coll and Taylor (2011), PD plays a key role in implementing a new curriculum as it is a requirement that supports the implementation stage. Having teachers tinkering with their existing traditional teaching methodology is not the aim of PD in a context of reform. For teachers to be seen as mediators and agents of change, PD needs to be designed and presented using means that enable teachers to transform their classroom practices to align with such change in the curriculum. Lave and Wenger (1991) stress that for change to take place, teachers need to act positively in a learning community where there is increased change in identity within that community. Since teacher learning in a CPD context implies that learning is an ongoing process, this view contradicts the type of learning that is pre-packed in ready-made programmes and presented to passive recipients.

Science teacher education in Saudi Arabia

The professional development programmes for Saudi teachers started officially with the launching of the General Directorate of Training at the Ministry of Education (MoE) starting from 1998 (Ministry of Education, 2014). The Directorate specifies methods of delivering CPD programmes. These are: lecturing, discussions, field visits, workshops, programmed learning and brainstorming. Findings from studies investigating CPD programmes indicate various issues of concern particularly in terms of the overemphasis on lecturing and discussions, the unsuitability of the CPD timing and scheduling of the programme, in addition to inadequate facilities at the training centres (Mansour et al., 2014; Alghamdi, 2011). As for assessing teachers and the CPD programmes, both formative and summative methods are used. Yet, according to Alabdualateef, (2007) and Alhajeri, (2004), the common practice actually being implemented is the use of summative evaluation with limited opportunities for follow-up and in-depth qualitative methods.

Two points should be noted about PD in Saudi Arabia. The first is that science teachers teaching in secondary, middle and primary schools attend PD sessions together. Second, training takes place in a gender-segregated fashion due to cultural issues. However, the recognition of the importance of PD programmes was associated with the implementation of the new science curriculum, through a project launched in 2008 and known by 'The Project of Mathematics and Natural Sciences'. It specialises in providing training programmes for both science and mathematics teachers. The King Abdullah Bin Abdulazeez Public Education Development Project, which is the official umbrella for the science and mathematics teacher development programmes, indicates that PD programmes should cover all requirements to deal with the implementation of the new curriculum. The programme includes various topics such as action research, cooperation with professional institutions in self-teaching development, the teacher as a researcher, and professional development programmes toward lifelong learning. These topics provide evidence that a new paradigm has appeared in PD programmes for science teachers in Saudi Arabia. Science teachers receive their CPD programmes as part of the implementation of the new science curriculum through a central system controlled by the Ministry of Education. Yet, training sessions and workshops have been criticised as usually too short and irregular to foster a change in teachers' classroom practice. According to the training section at MoE, PD takes place according to two main types: the first is through short-term PD programmes. These range from 3-5 days to less than two weeks of training. This type usually targets

teacher specific needs and is implemented before the beginning of the academic year. The second type of programme is much longer as they could last for a semester or even a whole year. This type of PD usually takes place mainly through university courses and on other occasions is hosted at international universities overseas. In general, CPD programmes are compulsory and require that teachers attend at least one training programme every five years of their profession. Attendance is taken into account when evaluating teachers at the end of every academic year as it is given 10% of their total grade. Incentives are given to teachers who enrol in CPD programmes as they are given priority when considered for administrative roles.

Challenges of curriculum reform currently taking place in science education in Saudi Arabia can be met if schools and other educational institutions are supported and helped. It is therefore necessary to design extensive CPD programmes which include the use of successful strategies to reach the ultimate goal of CPD, of transferring teacher learning to classroom practice (Darling-Hammond & Richardson, 2009; Hofstein, 2005; Loucks-Horsley et al., 2003).

Rationale

To be an effective science teacher, it is necessary to have the required dynamic understanding and abilities. Unfortunately, most new science teachers are not well prepared to meet the demands of their students (Alghamdi & Al-Salouli, 2013; National Research Council, 1996). Teachers are required to deepen their knowledge and improve their skills over the course of their careers in accordance with new science education standards (Hofstein, 2005) and curricula. In Saudi Arabia, the Trends in International Mathematics and Science Study (TIMSS) results, in both 2003 and 2007, indicate that students' performance in science is inadequate. Therefore a new science curriculum was adopted by translating and modifying the McGraw-Hill guidelines according to the environmental and philosophical context of the Saudi society. The new curriculum requires teachers to shift from traditional teaching methods to spending more time developing their subject knowledge, shifting from less shallow coverage of facts and procedures, to more in-depth focus on concepts and 'hands-on' engagement. Therefore, the reformed curriculum requires teachers' capacity to use instructional materials and inquiry-based practices, and create an investigative classroom culture. But teachers cannot cope with the new curriculum due to the lack of proper professional development provided, which would enable them to deal with such change. Almazroa and Alorini (2012) argued that much of the professional development that is offered to science teachers does not meet the demands of the new curriculum.

As far as the rationale is concerned, there is little, if any, evidence of research specifically targeted at determining effective models for CPD in Saudi Arabia for science teachers, particularly in primary, middle, and secondary schools. Thus, this paper investigates a vision for effective CPD for science teachers in Saudi Arabia so that educators, CPD providers and policy makers can develop programmes which could improve science teachers' quality and positive impact on their classroom practices. Therefore, the specific aim of the study is to contribute to a better understanding of how CPD can be planned and organised considering science teachers' experiences. It also aims at identifying the limitations and gaps in CPD practices and take previous research findings into consideration. Thus, the research questions for this study are as follows:

1. What are science teachers' views of the types of CPD provision provided in Saudi Arabia, based on their experiences?
2. What are science teachers' views of the content emphasis of CPD provision?
3. What are science teachers' views of an effective CPD provision?

RESEARCH METHODOLOGY

Based on the research questions and the complex nature of the issues under investigation, a mixed method approach of both qualitative and quantitative data collection was used. The mixture of data provides a rich empirical basis upon which we have made judgments about teachers' previous experiences and views on CPD programmes and their preferences for future CPD. Quantitative data were collected through a closed-ended questionnaire while qualitative data were collected through an open-ended question, 'What makes up effective CPD'. It has to be noted that the common practice for collecting data in most research studies in Saudi Arabia is based mainly on the use of closed-ended questionnaires.

Through the mixed methods approach, strengths of the qualitative and quantitative approaches are combined (Denzin & Lincoln, 2000). Guba and Lincoln (1989) emphasised the significance of the credibility of an instrument's stability to measure the constructed realities of the participants. The consideration to avoid researchers' subjectivity is called 'construct validity' (Dalgety, Coll & Jones, 2003). Dalgety et al. guided the procedure for developing a valid questionnaire. Both 'translation validity' and 'criterion validity' are two constructs that are required to ensure the instruments' validity. On the one hand, translation validity is concerned with the link between an item's design and its administration. An instrument is therefore considered to possess translation validity in the case where the theoretical constructs are well defined and inclusive (content validity), and if questions are good translations of the theoretical constructs (face validity). Criterion validity, on the other hand, considers the operationalism, as an instrument is considered to possess high criterion validity if the operationalism gives conclusions that are expected since they are based on theoretical constructs. In order to achieve the constructs of the questionnaire validity as stated above, four science educationalists were involved in reviewing the questionnaire, both the open-ended and closed-ended questions. Changes in the wording for some of the statements to avoid ambiguity were taken into consideration especially as the questionnaire had to be translated into Arabic for the teachers to understand. Suggestions that were made included the addition of more biography data to get as much information on teachers' background and to include university credited courses to the list of CPD opportunities.

Participants

The population for this study was all the science teachers in three educational administrations in Saudi Arabia (Mecca, Taif, and Almajmah). The total number of teachers in these administrations was 3150 while the total number of schools was 2035 (primary, middle, and high schools). However, for the sample of this study, the researchers targeted about one third of the population, so the researchers selected some educational districts under each educational administration with the consideration that the selection should cover both the urban and suburban areas. Three out of nine educational districts under Mecca educational administration were selected. For Taif, three educational districts out of ten were selected. For Almajmah, two educational districts out of four were chosen. The total number of teachers within the selected schools and districts was 1052 (485 males and 567 females).

Research procedure

The study included the implementation of an instrument that included closed-ended questions that yield quantitative data in addition to an open-ended question that resulted in qualitative data analysis. Respondents of the former were 609

teachers, whereas only 304 teachers responded to the open-ended question. Details of the questionnaire, data collection and findings are illustrated below.

Instrument and data collection

We developed a questionnaire specifically designed to collect data regarding science teachers' experiences of CPD programmes provided in Saudi Arabia based on a review of literature and related studies (i.e. Adey, Hewitt, Hewitt, & Landau 2004; Hustler, McNamara, Javis, Londra, Campbell & Howson. 2003; Kelly 2006; Loughran 2007). We followed a phenomenological perspective to come up with questions as the area of focus of this study is related to lived experiences by science teachers that gives meaning to the individual's perception (Chism, Douglas & Hilson, 2008). We asked the science teachers to determine the types of CPD offered to them in the preceding 24 months, their modes of participation and the emphasis of content and their suggestions for what makes an effective CPD programme in the future. Therefore, the questionnaire included various domains. Thirty-six items were represented in closed-ended questions. These were as follows: 12 items for science teachers' views on types of CPD provided to them, 11 items for their views on the content emphasis of CPD provision, and 13 items for their preferences of how they would participate in CPD programmes. Cronbach's coefficient alpha was used to calculate the internal consistency coefficients of these closed-ended questions. Results of the reliability analysis showed that the items in the instrument had a satisfactory discriminating power. Reliability coefficient alpha obtained for the whole instrument was 0.973; however, the coefficient alpha respectively for the first domain, the second domain and the third domain were 0.79, 0.95, and 0.91 respectively.

As for the fourth domain, this was an open-ended question where teachers could write freely their suggestions and views for what makes up effective CPDs. 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 covering letter explaining the purpose of the study, assuring teachers confidentiality (no names required), and stating that filling in the questionnaire was on a voluntary basis. The questionnaire was distributed to a random sample of 1052 Saudi science teachers, grades 1-12, in the three educational administrations. Every teacher in the sample was given a letter describing the study and a letter concerning human subjects' consent. Before responding to the questionnaire, teachers were required to provide biographical information covering gender, nationality, specialism, subject taught, prior teaching experience, qualifications and level of the school in which they work (i.e. primary, middle, secondary). Appendix 1 illustrates the questionnaire in its final form.

Data analysis

The closed-ended questionnaires were coded to enable the team to ascertain the corresponding respondent within the subgroups from different locations. A total of 609 teachers across all subgroups returned the surveys, with a response rate of 57.88%. Data were analysed using SPSS version 10. Descriptive statistics were calculated for the purpose of calculating percentages, means and standard deviations of science responses to the questionnaire. Out of the 609 teachers, 138 were teaching primary stage, 160 were teaching middle stage, and 311 were teaching secondary stage students. Most of the participating teachers held a B.S. in education (n = 569), whereas 25 teachers held a diploma in education and 15 teachers had earned a master degree. Their majors were biology (n = 195), physics (n = 133), chemistry (n = 166), general sciences (107), and earth science (8). At the time of the study, they were teaching general science (n = 299), biology (n = 91), physics (n = 99), chemistry (108), and earth science (n = 12). The teaching

experience of participants was less than 5 years for 217 teachers, and 6-10 years for 120 teachers while it was more than 11 years for 272. As for the open-ended question, only 304 teachers from the total sample responded with their experiences with CPD and views for future CPD programmes. The drawback in the number of responses to the open-ended question is a limitation that we acknowledge and suggest in future studies to have a different perspective to ensure a high response rate. One is to highlight to the teachers the importance of responding freely to such questions to add their voices and views. Another is the use of incentives for those who return the questionnaire on time with responding to all questions. Moreover, we could allocate a representative on behalf of the authors in each school to take this role and insure teachers' response to all questions. The respondents to the open-ended question included 93 male teachers and 211 females who 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. From these 304 respondents, there were 174 secondary teachers and 130 general teachers for the middle and primary stages. According to the specialities of the 174 secondary teachers, there were 53 physics teachers, 60 biology teachers, 57 chemistry teachers, 2 physics & chemistry teachers, and 2 geology teachers.

After transcribing the data from teachers' responses to the open-ended question, data were analysed according to the three phases suggested by Silverman, 2000. The first stage was to go through the data to identify the categories and sub-categories or themes regarding teachers' experiences and views of what constitute effective CPD programmes. The second stage was a 'constant comparative method', to concentrate on the most relevant categories to the research. This can be used to demonstrate the connections, causes and relationships. The third stage was to 'develop the categories into more general analytic frameworks' (Silverman, 2000, p. 144) by demonstrating how well the data is supported by evidence. These phases are a simplified model based on the work of Glaser & Strauss (1967).

FINDINGS AND DISCUSSION

Findings of the study are categorised into the following main assertions: the first assertion is related to teachers' views of CPD types of provision that were offered during the last 24 months before administrating the questionnaire. The second deals with science teachers' views about the content emphasis presented during the CPD programmes. Finally, the third assertion is about teachers' views of how to improve CPD provision programmes in order to form what could be seen as effective CPD provision. Each assertion focuses on answering one of the research questions of this study. Findings from the qualitative analysis are shown below where the identified themes and subthemes that relate to a particular assertion are illustrated with quotations from teachers' responses. For anonymity reasons, teachers were given codes and therefore each quotation includes the teacher's gender, years of experience, specialty and stage. The intention was not to compare results according to gender or years of experience, but to illustrate science teachers' broad views and experiences.

Assertion one: Types of CPD provision

'Out of school workshops' was the most highly ranked CPD provision type, while collaborative types where teachers form communities of practice or when teachers coach and collaborate with others were lower. As for individually initiated development plans through online activities, attending university credited or even non-university accredited courses, these were the least offered.

Table 1. Types of CPD provision offered to science teachers according to the frequency

Type of CPD	Frequency of offering n=609(%)	Ranking
Out-of-school workshops	61.6%	1
Attend a lecture or presentation	39.2%	2
In-school workshops	33.7%	3
Coaching done by other teachers	33.5%	4
Coaching for other teachers	17.7%	5
Collaborated as a colleague with other teachers	16.7%	6
Independent study	16.5%	7
Conferences	13.3 %	8
Cooperating with teachers in doing research in school	12.5 %	9
Online CPD	8.5%	10
University accredited courses	8.4 %	11
Non-university accredited courses	4.4 %	12

In order to know what types of CPD provision are presented to science teachers that could enable them to develop professionally, a 12-item list of various CPD types was presented in the first column of Table 1. For each item, the frequency of provision is illustrated by the percentage of science teachers who responded positively that they were offered the opportunity to participate in that CPD in the second column. The listed types of CPD provision are ranked in column 3 from the most frequently offered types to the less frequently offered types.

Findings show that 'out of school workshops' (61.6%) was the most frequently offered CPD type to science teachers. This indicates that teachers were mainly offered PD based on externally initiated views rather than those arising from direct issues which teachers were experiencing. This finding implies that learning is decontextualised rather than situated (Lave & Wenger 1991). Each of the following types: 'attending a lecture or presentation', 'in–school workshops' and 'coaching by other teachers' were offered to more than 30% of the participants. However, the other CPD types were not offered as highly as the ones above. For example, the 'online' CPD type was offered to only 8.5% of science teachers while the 'non-university accredited courses' was offered to 4.4% of the teachers.

Having the highest frequency of CPD offering in the form of 'out of school workshops' gives an indication that the providers of CPD programmes tend to perceive it as an external top-down provision initiated by an outsider rather than developing it from an insider bottom-up perspective that is based on teachers' needs analysis and actual classroom practices. In the outsider provision case, 'knowledge' could be seen as a transferable object. This view is supported by the various types of CPD known in the literature by the 'training model' (Kennedy, 2005), where teachers usually equate this model with official in-service training (Hulster, McNamara, Javis, Londra, Campbell, & Howson, 2003). Adding to this type of CPD provision, there is the 'deficit model' that is highly structured on a pre-set planned basis, where one-size-fits-all which is highly criticised in the literature (i.e. Clarke & Hollingsworth, 2002).

The findings also illustrate that 'attending a lecture or presentation' seems another common type of CPD provided to the science teachers, as according to 39.2% of the total sample it was ranked second in terms of its frequency. Such type of provision indicates that CPD is based on the transfer of knowledge where teachers are just receiving it passively rather than developing science teachers' skills which is a cornerstone in a discipline such as science with its experimental nature. Although 'in-school workshops' ranked third in terms of frequency, it actually gave about half of the responses of 'out of school workshops'. This variation in percentage only reflects the location of the CPD provision and does not delve into the details of who presents the provision, how long it takes or even the effectiveness and impact it may have on teachers' satisfaction and classroom practices. It is also

worth noting that types of CPD provision that require teachers to collaborate together such as 'collaborating as a colleague with other teachers', 'cooperating with teachers in doing research in schools', and 'online CPD' all ranked low (6th, 9th, 10th respectively) in comparison with types that require individual work or an authoritative learning environment where forming communities of practice (CoP) is not the norm. This raises questions in regards to the outcome of such programmes on teachers' professional identity and how they view their learning to serve their professional needs and contextual requirements.

When teachers were asked to suggest how to improve CPD provision to be more effective through the open-ended question, they responded by making several suggestions, some of which relate to the type of CPD provision that links to what each location could offer. From the 304 teachers who responded, the location of where CPD programmes are conducted was indicated by 118 teachers (35.32%), and the importance of having certain facilities in such locations was indicated by 39 teachers (11.67%), as shown in the following part.

Suggestions for CPD programme locations

Four locations were recognised in teachers' responses. These were CPD training centres, schools, local educational district offices and universities. From the patterns identified from the responses, teachers were more inclined to the notion that CPD is a concept that ties directly to training centres out-of-school rather than in-house school-based programmes which recent literature emphasised is a deliberate shift. This shift is in response to teachers' needs and acknowledges communities of practice within the one school rather than programmes that are imposed on all teachers, despite their direct needs.

CPD programmes in training centres

A total number of 74 responses suggested having the programmes in training centres 'Training centres are appropriate as they are equipped with the necessary facilities. But some teachers avoid attending due to the distance these centres have from the city centre.' (Female chemistry teacher in secondary school, 10 years of experience.)

CPD programmes in schools

A total number of 28 teachers preferred having CPD programmes on school premises. One of the responses referred to teachers participating in decision-making with the school administration in all aspects related to the curricula and therefore suggested that CPD programmes should take place in schools, '…at school as this helps provide for an administrative structure where teachers are involved in decision-making in aspects related to curricula.' (Female physics teacher, 18 years of experience)

A secondary teacher added his logic in having CPD programmes in schools as this is where the programmes will be implemented. He said: 'It is preferred to having them in schools and to specify a certain class as a standard place where all pedagogical experiences are implemented.' (Male chemistry teacher, 6 years of experience.)

CPD programmes in local educational district offices

A limited number of teachers, 13 teachers, suggested that CPD programmes could take place in local educational district offices where supervisors' offices and centres are located. 'In supervisors' offices and centres' (Female chemistry teacher in secondary school, 25 years of experience).

CPD programmes in universities and higher education institutions

Universities and higher educational institutions were also a preferred place to a limited number of teachers in the responses of three teachers. One secondary teacher stated: 'It is better to have CPD programmes in universities and higher education institutions as they are equipped with the necessary facilities.' (Female chemistry teacher in secondary school, 16 years of experience.)

Locations with reference to facilities

Teachers' responses also included reference to the criteria of the location regarding how well they were equipped. This relates directly to the discipline of science as professional programmes presented to science teachers should vary from those offered to teachers of other disciplines. And since the nature of science is experimental and hands on, teachers, from their responses, seemed to appreciate such variation from other disciplines.

> That the location should be where there are labs and facilities that are appropriate for the newly developed programmes. (Male general science teacher, 27 years of experience.)
> Equipped with all necessary facilities and training aids that can guarantee achieving the aims of the CPD programme. (Female physics teacher, 3 years of experience.)
> Rooms that are appropriate in terms of capacity and equipment. (Female general science teacher, 16 years of experience.)

It has been noted that the trend is to conduct a school-based professional development approach in order to tackle direct problems facing teachers in their own schools. This came as a result of the positive outcomes of such an approach to teacher professional development (Coolahan, 2002). From these outcomes comes that teachers acknowledge tensions and challenges experienced in their science teaching on a daily basis (Nielsen, 2012). By such acknowledgement schools can expect teachers' translation of their training into positive and participatory action (Boaduo, 2010). However to ensure such translation, factors such as teamwork, that requires teachers' understanding and practices of collaborative work, is considered to be one of the major factors (Robinson, 1999). Teacher collaboration with an aim to discuss their practices and gain support from each other by providing a positive environment for professional dialogue (Eraut, 2001) and enhance learning has been the focus of studies and reports such as the report by the Centre for the Use of Research Evidence in Education (Cordingley & Bell, 2012) that identified through meta-analysis the impact of CPD on students' learning outcomes, when collaborating between teachers working together, sharing evidence about their practice and forming networks within and between schools is key to what is called 'high quality professional development'. Despite such emphasis in the literature on school-based professional development, teachers in this current study through their open-ended responses indicated that what they had experienced the most in their CPD programmes was out-of-school CPD.

Assertion two: Emphasis on content

Content of CPD programmes set by the providers stressed more on 'thinking skills', 'curricula development and instruction', while stressed less on 'leadership skills', 'assessment' and 'content knowledge'.

The closed-ended questionnaire presented teachers with a list of content items that CPD provision could have emphasised through the CPD programmes they had attended in the preceding 24 months. Teachers were asked to rate each content item. Teachers' responses were coded from 1-5 as follows: 1= none, 2= very low emphasis, 3= low emphasis, 4= high emphasis, and 5= very high emphasis. The

Table 2. Descriptive statistics of teachers' views of the content emphasis of provided CPD provision

Emphasis of CPD content	Mean	SD	Rank
Thinking skills	4	.83	1
Teaching and learning methods	3.96	.69	2
Design and develop curriculum	3.91	.92	3
Behaviour management in the classroom	3.86	.81	4
Learning to learn	3.85	.90	5
Approaches to assessment	3.82	.75	6
Pupil consultation	3.79	.92	7
Catering to the needs of different pupil groups	3.72	.90	8
Leadership development	3.66	.93	9
Use of ICT in learning	3.65	1.06	10
Deepening knowledge of subject area	3.48	1.18	11

descriptive statistics (mean, M and standard deviation, SD) are reported in Table 2. The results indicate that the mean score for all the listed aspects are above 3.48 out of 5.00. Thinking skills (X = 4), teaching and learning methods (X = 3.96), designing and developing curriculum (X = 3.91) were among the highly emphasised aspects of CPD in Saudi Arabia. On the other hand, the aspects of CPD that were relatively less emphasised were developing leadership (X = 3.66), using ICT in learning (X = 3.65) and deepening knowledge of subject area (X = 3.48).

The aspects listed in Table 2 are ranked from the most frequently emphasised content items to the less frequently emphasised. From the findings, it seems that there are various efforts by the providers to present science teachers with content that could be beneficial to them especially since there are efforts lately to reform the science curriculum. It seemed rather logical that providers acknowledged such reform by offering CPD programmes that could equip and prepare teachers to deal with the reformed science curriculum.

Previous literature gave much emphasis in reform contexts to content related to leadership skills and content knowledge. Klentschy (2008) and Yager (2004) for example envisioned that teachers need to have leadership skills to operate in their classes and help transform their classes to follow or even to initiate reform. However, although teachers acknowledged that leadership skills were included in CPD programmes, this contradicts what teachers themselves stated in terms of the types of CPD that were offered to them as illustrated in Table 1. It also contradicts what researchers claim as recognising teacher leadership as a main ingredient to support educational reform (Hanuscin, Rebello & Sinha, 2012). It also contradicts claims by Darling-Hammond, Bullmaster and Cobb (1995) that teacher learning links to teacher leadership. In this sense, envisioning leadership as a feature of teacher learning is likely to impact teachers in their classroom practices and school capacity to respond to teacher and student needs. Another interesting finding from the closed-ended questionnaire is that science content was the least presented content in CPD programmes as it ranked last on the list. This raises questions as to the separation made between pedagogical content knowledge and content knowledge that researchers claim go hand in hand for an effective teacher (Shulman 1987). The qualitative analysis reported that 81 teachers from the 304 (26.64%) highlighted certain content in future effective CPD provision. Responses basically seemed to reflect teachers' needs whether it were teaching strategies, content knowledge, technological aspects, assessment, or practical work. The following sections show details.

Science content knowledge

Science content knowledge was highly recommended by teachers to be included in CPD programmes, as 33 teachers stated this aspect. Teachers on some occasions went further, to even suggest certain topics that relate to the content knowledge and topics they teach in the school curriculum. This raises questions of how appropriate

teachers' content knowledge was for them to teach science. It also relates to their educational programmes at the School of Education as pre-service teachers and how well they are prepared. But most importantly, this raises questions about the influence of the curricula on teachers' perspectives and expectations of CPD programmes. In addition, this reflects the extent to which teachers are dependent on CPD to develop their content knowledge. Examples from teachers' responses to the open-ended question are as follows: 'Constant follow-up on any new scientific advancements.' (Male general science teacher, 4 years of experience.)

Other teachers suggested that topics should relate directly to the content and curriculum they teach students at school: 'Everything that relates to the school curriculum.' (Female chemistry teacher, 18 years of experience.) 'Train on the reformed curriculum and how to deal with it in addition to searching for new ways of teaching.' (Female general science teacher, 12 years of experience.)

Teaching strategies

Eighteen responses focused on including pedagogical strategies as their suggestions for CPD content. Examples included the use of constructivism, problem solving and cooperative learning. One physics teacher said;

> The content [of the CPD programme] should relate to the curriculum and everything that relates to how to teach it starting from the introduction to the assessment passing on every single detail including practical experiments. (Female physics teacher, 14 years of experience.) Constructivism was highlighted as a need, especially by a novice physics teacher: 'Contemporary teaching strategies, especially constructivism. (Female physics teacher, novice).

Application and model lessons

This suggested content topic was reported in ten responses. Teachers stressed that programmes should include opportunities for them to apply the ideas and pedagogical practices. They also suggested having model lessons to clarify the major concepts and practices before they leave the programme. This seemed to indicate the need for more than lecturing and presentations. Hands-on and experiential practices are key to applying CPD learnt practices and transferring such practices to class, especially given that the responses came from science teachers where hands-on is a must in order to highlight the nature of the discipline.

> That the content of the programme has hands-on examples rather than large amounts of theoretical knowledge and lots of boring talks and discussions that take a lot of the programme's time, in addition to including a model lesson of the reformed curriculum and explain the teachers' guide and how to use it in a detailed way. (Female chemistry teacher, 10 year of experience.)
> Intensify the number of hands-on examples included in the programme in order to help understand the teaching strategies better and help apply them easily. (Female general science, 18 years of experience.)

One primary teacher made a desperate call for finding applications in CPD programmes in the following comment: 'We need workshops with detailed practical lesson guides that show teachers step by step procedures, if only there were opportunities for application.' (Female general science teacher, 11 years of experience.)

Practical experiences

Other responses, eight of them, included reference to how science works and how to carry out experiments and activities whether in class or in the science labs, in another acknowledgement of the nature of science and the need for hands-on

experiences from both teachers and students alike. 'The content should include hands-on experiences of all the practical experiments that are included in the reformed curricula and emphasis on developing teachers' science practical skills effectively.' (Male physics teacher, 4 years of experience.)

In general, although there has been little attention given in the literature to the content presented in CPD programmes (Garet, Porter, Desimone, Birman, & Yoon, 2001), the content presented to the science teachers through professional development programmes is expected to be of interest to them in order to be acknowledged as useful and beneficial to their classroom teaching practices and student learning. In a study in Taiwan, Lee (as cited in Wan & Lam, 2010) there are claims that the most effective factor in determining and facilitating for effective professional development is the relevance of the presented content and how realistic it is. Explanations of this could be traced back to earlier studies in teacher development such as Shulman, (1987), who stressed on various types of content that teachers should acquire and develop. These are 'pedagogical knowledge' (PK), 'pedagogical content knowledge' (PCK), and 'content knowledge' (CK). Other studies in the same vein stated that professional development must focus on subject-matter knowledge and deepen teachers' content skills. (Cohen & Hill, 1998; National Research Council, 1996).

In order to make the reformed curriculum a classroom reality, a holistic system of reform needs to be taken into account; one that allows for room to change in terms of timetables, instructional spaces and recourses. From this standpoint, teachers' suggestions had a great emphasis on science content knowledge and aspects related to the nature of science (NoS), especially the experimental and investigative nature which the reformed curriculum calls for. Almazroa (2013) asserted that Saudi science teachers found that implementing inquiry-based instruction in science classes is hindered due to various factors such as class capacity, student diversity, lack of laboratory facilities, and equipment, technology and time limitations. Science classes are short which makes it difficult to conduct proper fieldwork, lab investigations and group work thus inquiry or problem-based research seems challenging. Studies that included explicitly NoS in teacher professional development programmes illustrated teacher gain in some aspects of NoS (Posnanski, 2010). Teachers, nonetheless, did not neglect the need for pedagogical knowledge.

Assertion three: Effective participation in CPD activities

'Teachers preferred to attend programmes where they act as passive recipients of knowledge rather than cooperating with others or even leading groups, while to other teachers, active participation and engagement was preferred'.

To determine the nature of science teachers' preferences of participation in CPD programmes, they were asked to identify the five most highly preferred types of participation in CPD from a list of 13 types. The percentage of teachers who selected each type of CPD participation and the ranking of each type are listed in Table 3.

By looking at the findings that indicate teachers' preferences of what type of activity to participate in CPD, it could be divided into three main types: traditional passive activities; collaborative activities; and leadership activities. In the first type, passive, this is where teachers observe demonstrations (65.4%) and listen to a lecture (53%) or follow a presentation through activities that may not seem to help teachers take positive roles in their classes in order to implement reformed curricula. In this regard, having a passive role while attending CPD programmes as the preferred type of participation shows that teachers are trapped in the mindset of the providers and do not seem to acknowledge the change needed to go about with the reformed science curriculum. When looking at involvement in assessment,

Table 3. The percentages of teachers who prefer each type of CPD participation

Types of CPD participation	Responses %	Rank
Observe a demonstration of a lesson or unit	65.4%	1
Participate in a small-group discussion	63%	2
Engage in extended problem-solving	57 %	3
Listen to a lecture or presentation	53%	4
Assess pupil work	49.1%	5
Develop or review materials	38.8%	6
Collaborate as a colleague with other teachers	38.4%	7
Conduct a demonstration lesson, unit or skill	36%	8
Produce a paper, report or plan	34.6%	9
Give a lecture or presentation	25%	10
Assess fellow participants' knowledge or skills	23.3 %	11
Lead a small-group discussion	22.8%	12
Lead a whole-group discussion	18.1 %	13

findings indicate that assessing students is preferred over assessing peer teachers; this also indicates that the expected role of teachers in the Saudi context is more of a traditional type based on authoritative roles on student learning rather than a collaborative role with other teachers.

Disregarding CPD types of participation where teachers take active roles by either collaborating with peers (38.4%) or by leading small (22.8%) and whole group discussions (18.1%) deprives teachers from participating in what is called 'reform' types of activities (Garet et al., 2001) that are more responsive to how teachers learn (Ball, 1996) and may lead to changes in teacher classroom practices (Darling-Hammond, 1995). One of the explanations of the need to have CPD types of participation where teachers collaborate together is that teachers teaching to others could be more beneficial than when done by an expert outside trainer. This has been explained as teachers being more involved in daily classroom experiences and therefore would be able to articulate more on problems which they all face (Sandholtz, 2002). Neglecting such experience could affect teachers' professional identity since they are used to individual types of work rather than collaborative ones with other teachers. Table 3 shows that 'collaboration with other teachers' ranked 7th out of 13 different types of CPD. To some studies, this type of collaborative work although identified differently by 'teacher networks', 'communities of practice/learners' and 'peer coaching', all share the positive impact of this collaboration and collegiality of teacher co-learning in various aspects such as to improve instruction (Cordingley, Bell, Thomason & Firth, 2005), teacher self-efficacy (Chong & Kong, 2012), and change in beliefs (Cordingley, Bell, Rundell & Evans, 2013).

From the findings, there is an indication that teachers did not seem to be involved in CPD programmes that require them to take active leadership roles. They seemed to be acquainted with always being passive receptors and being directed by others, whether the Ministry of Education (MoE) or CPD providers. Leadership roles also seemed to be last in their minds, as this ranked 12th out of a list of 13 items. Such findings could play a major role in shaping teachers' professional identity and how they perceive themselves in terms of their ability and expected roles in their teaching profession. Such a relationship between teachers and providers seemed to be shaped through an 'authoritative' relationship rather than a 'partnership' relationship. Authoritative bodies are ones who know best for the teachers and are

able to shape teachers' experiences according to what fits best. The type of relationship that needs to replace 'authoritarianism' is a 'partnership' where ideas are shared and needs are respected and taken into account.

Teachers attending CPD programmes did not seem to indicate the importance of participating in activities that require the development of teacher leadership skills. This is contrary to the view of Katsenmeyer and Moller (2001) who define teachers as leaders, as those who lead beyond the classroom, contribute to a community of teacher learners and have the ability to influence others towards improved educational practice. Informal leadership could also take place within the context of CPD when teachers share their experience and expertise with others and volunteer for new projects or bring new ideas to the school, so in conclusion act as a powerful tool for school improvement (Leithwood, Jantzi, & Steinbach, 1999) especially in a context such as that in Saudi Arabia where reform is taking place. Successful school reform has been strongly linked to effective school leadership (Harris, 2003; Ofsted, 2000 in Ghamrawi, 2013, p. 171) especially where the roles of teachers as leaders extends to taking the role of a catalyst of change, learner, mentor and even learner facilitator (Harrison & Killion, 2007).

A TRANSFORMATIVE FRAMEWORK FOR EFFECTIVE CPD SCIENCE PROGRAMMES

According to the analysis of the data and the three main assertions, the following discussion paves the way for a framework for designing effective CPD. The framework is designed in light of teachers' perspectives and their professional identity that surfaces in discussing teacher learning through exposure to CPD programmes. Figure 1 illustrates the major findings of this study and proposes the framework that could help move away from some of the issues that exist in current CPD practices. Moreover, it provides for a different perspective based on collaboration, partnership and professional identity. The figure presents what teachers have experienced from the CPD providers in terms of the types of opportunities science teachers were offered, the content, and the activities that teachers participated in. The figure also presents what teachers view and prefer to experience in future CPD to be more effective in terms of the types of opportunities science teachers could be offered, the presented content and activities to participate in. From these two points of view the concept 'professional identity' surfaces to the discussion. Professional identity brings along with it how it could be developed in a positive manner through school-based reform, partnerships with CPD providers, establishing communities of practice within schools and finally a positive proactive leader as an agent of change.

According to what CPD providers presented to science teachers, teachers in this study were accustomed to out-of-school workshops and had limited exposure to collaborative and self-initiated learning experiences. This indicates the presence of a 'deficit model' (Kennedy, 2005) of CPD where teachers are passive recipients of a pre-set package of knowledge and skills. This finding concurs with Anderson and Togneri (2005) and Fullan (2003) where teachers may see themselves as the objects of reformers rather than active participants or even initiators of change. According to the findings and frequencies in Table 1, the types of CPD which the science teachers experienced were mainly traditional types yet collaborative types were average and self-initiated were the least presented type of CPD.

Strangely, when the science teachers were asked to select their preferred type of CPD they referred to those that they were used to attend; CPD programmes that are in a non-partnership mode and where providers set the tone and decide for every detail (EL-Deghaidy, Mansour & Alshamrani, 2014). This finding indicates that
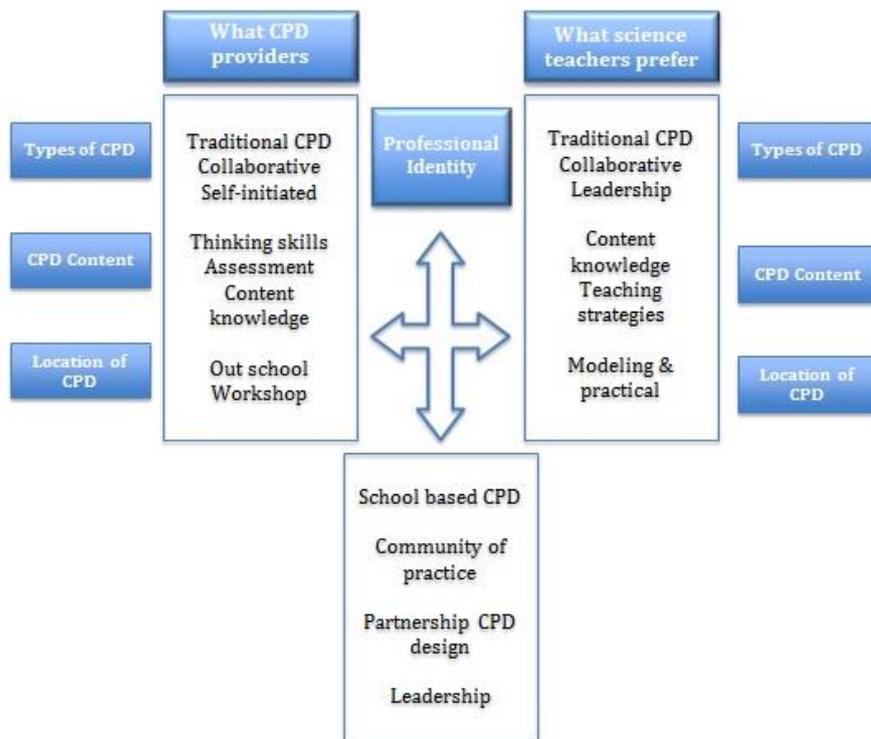
Figure 1. Framework for effective CPD for science teachers

teachers have views and preferences of traditional types of CPD where teachers are receiving knowledge either by listening to lectures or by observing the trainers throughout workshops. The least CPD types were those that required teachers to take positive leadership roles. Nonetheless, in terms of a reform context, it is expected that teachers act as change agents and not as passive recipients. The framework therefore shifts from the current practice experience in CPDs to one where developing a positive professional identity is at the core in order to support and initiate science reform.

Still, when asked about the content, the presented content seemed challenging and appealing as a requirement for the reformed science curriculum (i.e. focusing on thinking skills, problem solving skills, assessment; and the least was content knowledge). The content which teachers preferred to focus on was mainly science content knowledge, teaching strategies and content related to the nature of science. Having the material presented using a 'one size fits all' may not be that helpful as a means to facilitating for reform and change. This is indicated as little was done in presenting leadership skills and collaborative collegial communities to teachers who were expected to be perceived by themselves and others as change agents in a reform context. This contradicts findings from the literature (e.g. Loucks-Horsley et al., 2003) as encouraging teachers to take responsibility in leadership roles in order to sustain improvements as a result of CPD experiences. Teachers' views in terms of the content needed were different from what was presented. This finding extends what EL-Deghaidy et al. (2014) and Mansour et al. (2014) found when analysing teachers' typology of CPD activities and investigating science teachers' needs.

Leaning on research from professional development and reform, there are claims that professional identity is a key to teachers' commitment to change (van Veen & Sleegers, 2005). Drake, Spillane and Hufferd-Ackles (2001) stated how teachers perceive, adapt and are influenced by the extent to which they challenge and reconstruct their existing identities. Through the framework for effective CPD, professional identity could therefore be seen as a useful 'research frame' as it deals with teachers as whole persons in and across social contexts. Social contexts could

be developed and sustained in a school context through communities of practice where their identity develops and where they provide support to each other. In these contexts, teachers are in a continuous process of constructing and re-constructing views about themselves in relation to others; professional purposes; and cultures of teaching (Lamote & Engels, 2010). From the findings, it seems that both providers and teachers overlooked the concept of teacher professional identity and as a consequence the concept of leadership was also overlooked. Leadership is a main aspect to enact any reform efforts where teachers share their knowledge and experiences. In trying to understand why leadership was overlooked, it could be that the cultural aspect embraces little on leadership since the types of CPD were mainly where teachers acted as recipients rather than creators. In a centralised top-down system this could be a possible reading to having such a result. Collay (2006) used the term 'semi-professional' referring to the role teachers play in such an educational system rather than seeing themselves or even being seen by others as 'change–makers' or what Lambert (2003) mentioned, enacting leadership actions. In a culture where reform is top-down, developing and embracing teacher leadership could be a daunting task to address the need to establish a 'reform minded science teacher' (Luehmann, 2007, p. 821). Introducing reform in science education is much more than just engaging teachers in acquiring knowledge and skills. It is about expecting teachers to enact such knowledge and skills only when they are empowered to do so and when the policymakers enable them. The anticipated framework of an effective CPD is therefore one that empowers teachers to lead reform initiatives; teachers who are proactive in a community of change to suggest where reform is needed rather than becoming superficial followers of a top-down reform. The framework springs from the notion of school-based reform where actions and suggestions are dealt with in context rather than at out-of-school based training centres. The framework builds its strength from teachers partnering with CPD providers to develop content to address teachers' science classroom practices especially when new a curriculum is implemented.

CONCLUSION AND IMPLICATIONS

In general, the findings of this study pave the way to develop a framework for future CPD programmes in Saudi Arabia for science teachers that articulates their professional identity as an outcome of how CPD isexperienced and preferred. It also sets out plans as to how, what and where they envision their learning to benefit the most. CPD providers might need to restructure and concentrate future CPD on collaborative school-based and independent self–initiated types that help teachers move from traditional types of CPD provision. The main features of the framework include the provision of a school-based CPD where the content is developed in partnership between teachers and CPD providers. Having this is mind, there needs to be more emphasis on collaborative activities where teachers can share and exchange experiences together in a safe community that supports each other and increases collegiality, in addition to activities that require teachers to take leadership roles. Moreover, in terms of the content, focusing on science content knowledge, the nature of science and developing leadership skills are priorities to provide for positive conditions to implement and transform what is learnt in CPD and enact practices in the classroom content as a precondition for coping with reform (Pyhalto, Pietarinen & Soini, 2012).

The findings clearly showed that what teachers experienced through CPD programmes set and designed by the providers and what teachers suggested as future types were more or less similar hence forming teachers' professional identity. Yet it was clear also that there was a mismatch and confusion as to how teachers were professionally identified. With high expectations of a reformed curriculum,

focusing the PD content on thinking skills and extended problem-solving was not in teachers' listed professional needs but only there in a manner to help with the reformed curriculum. In this sense, a reformed science curriculum requires a paradigm shift in CPD programmes to help teachers transform their experiences to the classrooms. The use of simultaneous reform happening both bottom-up and top-down requires identity-building to help teachers change the way they view themselves and their roles in the educational system. This can take place, according to Pyhalto et al. (2012) where there is change at the 'root level' in terms of pedagogical practices and decision-making. This implies that the role of a science teacher in a context of reform needs to be taken into account by emphasising types of CPD and content that addresses the needs of the teachers (Mansour, et al., 2014). The study draws the attention of decision-makers and policy-makers to the fact that teachers cannot act as expected by providers; they need to be perceived in a different manner. Teachers' professional identity matters in how they can lead a reformed curriculum, hence, teachers should be encouraged to lead groups and work collaboratively.

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Appendix. Questionnaire

About the Questionnaire:
This questionnaire asks for information about school education and policy matters. The questionnaire should take approximately 30 minutes to complete. Guidelines for answering the questions are typed in italics. Most questions can be answered by marking. When in doubt about any aspect of the questionnaire, or if you would like more information about it or the study, you can reach us by phone at the following numbers: [] or e-mail
Thank you very much for your cooperation!

Please put a tick [√] where appropriate

1- Gender Male [] Female []   **2- Nationality**   Saudi [] Non-Saudi []

3- Your specialism:
Biology [] Physics [] Chemistry [] Earth sciences [] General science [] Mathematics [] Other   []

4- The subject you teach:
General science [] Biology [] Physics [] Chemistry [] Earth sciences [] Mathematics [] Other   []

5- Years of your teaching experiences
5 years [] 2) 6-10   [] 3) 11-15   [] 4) 16-20 [] 5) > 21   []

6- Type of your qualification:
Educational []   Non-educational []

7- The latest qualification:
Diploma in Education   B.Sc. in Education   Master in Education   PhD in Education   Other, (specify)...

8- The school you are working in:
Government   []   2) Private []

9- The school level you are working in :
primary,   middle   secondary

10- What are the CPD opportunities that have you been provided with?
CPD opportunities offered to school teachers

No.	Types of CPD	Yes	No
1	In-school workshops		
2	Out-of-school workshops		
3	University accredited courses		
4	Non-university accredited courses		
5	Online-CPD		
6	Observation of peers teaching		
7	Coaching done by other teachers		
8	Coaching done for other teachers		
9	Conferences		
10	Teacher networks or collaboratives		

11	Cooperating with other teachers on doing research in school
12	Attend a lecture or presentation
13	Independent study
14	Others

11- Emphasis of CPD activity (content) *What was the content emphasis of CPD activities in which you did spent most of your time?*

No.	Emphasis of CPD activities	No emphasis	Little	'Quite strong emphasis'	Strong
1	Design and develop curriculum				
2	Teaching and learning methods				
3	Approaches to assessment				
4	Behaviour management in the classroom				
5	Use of ICT in learning				
6	Catering to the needs of different pupil groups				
7	Deepening knowledge of subject				
8	Leadership development				
9	Thinking skills				
10	Pupil consultation				
11	Learning to learn				
12	Others				

12- *Identify up to five forms of activity in which you did spend the most of you time engaged in while participating in CPD programmes?*

No	Forms of CPD activity
1	Listened to a lecture or presentation
2	Participated in a small-group discussion
3	Collaborated as a colleague with other teachers
4	Led a small-group discussion
5	Led a whole-group discussion
6	Gave a lecture or presentation
7	Assessed pupil work
8	Developed or reviewed instructional or curriculum or materials
9	Observed a demonstration of a lesson or unit
10	Conducted a demonstration lesson, unit or skill
11	Produced a paper, report or plan
12	Assessed fellow participants' knowledge or skills
13	Engaged in extended problem solving

13- *From your experiences with previous CPD programmes, write your suggestions and views for what makes effective CPDs*