



Continuous Professional Development in Science Education: A Reconceptualisation

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Abstract

Continuous Professional Development (CPD) has the potential to enhance teachers' confidence and competence in science education leading to improvement in classroom practice and pupil learning outcomes. International prioritisation of Science Technology Engineering and Mathematics (STEM) education is indicative of a pivotal movement towards enhancing CPD in science education. It is imperative that teacher educators develop a strong knowledge base of the prominent factors that influence CPD. This paper will discuss teacher motivation to participate and engage in CPD, leading to examination of the characteristics of effective CPD and consideration of the change process. An innovative conceptual model emerges which synthesises literature in the field and will inform development of future programmes of CPD in science education.

Keywords: Professional Development, Primary Science Education

Introduction

There is a growing body of international and national research highlighting concerns about the teaching and learning of science in primary schools [1], [2], [3], [4], [5]. Many have identified teachers' confidence and competence in teaching science and insufficient levels of scientific content knowledge as challenges teachers face [4], [5], [6]. Day [7] describes CPD as a personal, professional and social process through which "teachers review, renew and extend" their teaching, and develop and acquire new knowledge and skills (p. 4). The underlying assumption is that effective CPD in science education will improve teachers' pedagogical capacities, lead to more effective teaching, and enhance pupil learning outcomes [3], [4], [8]. At an international level, STEM reports and policies (for example [9], [10]) have prioritised CPD in science education. For CPD to be effective, teacher educators require a strong knowledge-base of the factors that influence CPD. Thus, this paper will synthesise literature on CPD for in-service teachers in science education, beginning with a review of the literature pertaining teacher motivation.

Teacher motivation

Teacher motivation to participate is fundamental to the success of CPD [11], [12]. Motivation is generally viewed as the energy or drive that moves someone to act. Supported by an array of literature, personal choice is a primary intrinsic motivator for engagement in CPD [13]. Teachers are intrinsically motivated if they are interested in an area or if they are challenged by problems they encounter in their classroom [14]. School context and wider system factors which further motivate or inhibit participation in CPD must be considered [13]. For example, enforcement of 'top-down' approach to CPD where a teacher participates in CPD only because of the influence of management or peers is unlikely to stay on-course [15]. Motivational theorists assert that such regulation would result in compliance and low levels of self-determination [12], [16]. Research argues that optimum conditions for CPD involve a whole school approach whereby teachers are involved in planning CPD and supported by school management who share a common commitment to examining and improving practice [17], [18], [19].

Motivation remains a critical yet understudied component of teacher CPD [16]. In science education much of the research on CPD has focused on volunteer teachers whose mere voluntary attendance is indicative of their motivation to change or try something new [20], [21]. If teachers are not motivated to participate, characteristics or models of CPD, no matter how effective and well-designed, may be futile. Consequently it is of some concern that models of effective CPD often fail to make explicit reference to the motivational factors which underpin the entire process [16]. This paper argues that motivational factors form an essential part of a conceptual model of CPD in science education.

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Characteristics of effective professional development

A number of educational researchers have summarised an extensive array of literature on CPD [22], [23]. It is apparent that the characteristics of effective CPD are numerous and complex, with no 'one correct' CPD model. Effective CPD is context-bound, with different levels of teacher motivation and support. Teacher educators must have a deep understanding of teacher learning and consider the context to justify the CPD design. A comprehensive analysis of the characteristics of effective CPD intertwined with teacher learning theory is presented.

CPD programmes that focus on both subject knowledge and how children learn are found to have a positive impact on teachers' practice and pupil learning [3], [11], [22]. Research has shown that high percentages of teachers cite lack of content knowledge as a significant concern [3], [6]. Deep understanding of subject matter is needed to accommodate children's questions and investigations. In addition the literature repeatedly highlights teacher difficulties with the constructivist and inquiry-based pedagogies [1], [2]. Therefore aligning the content of CPD to teachers' prior knowledge, beliefs and experiences is imperative. CPD must draw on adult learning theory and cognitive perspectives on learning. Congruent with Piagetian notions of cognitive development, learning occurs when teachers compare their current practice with new experiences. Teacher educators must use teachers' current practice to create a significantly high level of cognitive dissonance to challenge inadequate scientific conceptions and traditional didactic approaches to teaching science [24]. Collaborative, collegial relationships with a high degree of trust and mutual respect is necessary so that teachers feel comfortable sharing prior experiences [20], [25]. Researchers highlight the importance of giving teachers' reflective time in which to review and critically think about their practice [26], [27]. Teachers already teach science and any new ideas not only require adoption of new content and pedagogical approaches but also often abandonment of deep rooted beliefs that have been a significant part of a teacher's personality [28]. Without reflection, surface changes may be acquired and uncritically and easily disregarded after CPD [29].

Therefore teacher educators must ground characteristics of effective CPD in teacher learning theory. Many established CPD models fail to explicitly mention the importance of teachers' existing practice [23], [30]. This paper argues that teachers' experiences be positioned at the beginning of a CPD model and used as a springboard for the development of CPD, as presented in the below conceptualisation model (Figure 2). Cognitive dissonance, reflection and professional learning activities should follow. However CPD is more than a sequence of activities; it is a process of putting knowledge into classroom practice within a community of engaged practitioners. Hence CPD must be sustained throughout the implementation process and not comprise a one-off intervention.

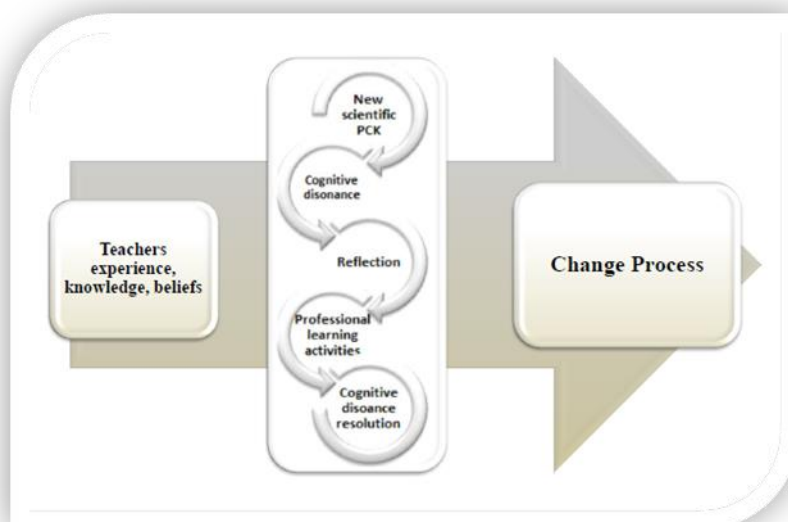


Fig.1: Model of teacher learning in CPD (Source; after author)

Sustaining Change

Guskey's [23] assertion that the primary goal of CPD is to change teachers' practice and improve pupil learning outcomes is widely accepted and his model of change is well-established. Fullan [29]



maintains that well-intentioned improvement efforts tend to lose momentum over time referring to “a dip in performance and confidence as one encounters an innovation that requires new skills and new understanding” (p. 40). Similarly Kennedy [31] refers to the problem of ‘enactment’ in which teachers can learn one idea but continue enacting a different idea when teaching. Support is required to maintain motivation during the change process. Professional Learning Communities (PLC) offers a feasible infrastructure to sustain CPD throughout the change process.

Stoll et al. [32] define a ‘learning community’ as a school in which “an inclusive group of people are motivated by a shared learning vision, support and work with each other, find ways inside and outside their immediate community to enquire into their own practice, and together learn new and better approaches that will enhance all pupils’ learning” [32, p. 6]. Researchers have found that PLCs enhance teachers’ pedagogical skills, knowledge, motivation and enthusiasm in a combined effort to enhance the quality of teaching [32], [33]. The underlying assumption is that through collaboration change can be sustained [34]. Teacher educators should be equal partners in this community providing continued assistance, support and feedback to teacher and schools [12], [35]. The traditional assumption of researcher-as-theory-creator and teachers-as-theory-applier must be diminished. Teacher educator-school relationships have been proven to positively impact teacher self-efficacy and enable teachers to develop rich and extensive knowledge to support learning and improve instruction [36].

Evaluation is a crucial stage of the change process for both teachers and teacher educators [17], [30]. Guskey [17] maintains that CPD is not deemed effective unless there is evidence of enhanced pupil outcomes. It is imperative therefore that feedback is provided throughout the CPD process to assess impact of teachers’ practice on pupils’ performance. Kennedy & Shiel [37] found that once teachers began to experience success and saw the enhanced engagement, motivation and achievement of pupils, it empowered the teachers further. Smith [3] and Murphy et al. [4] reported similar findings. Figure 3 below presents a conceptual model of the change process in CPD. Surmising teachers need sustained support throughout the change process. PLC would provide such support. Feedback is necessary to motivate teachers to sustain new practice, while evaluation is a fundamental component of CPD.

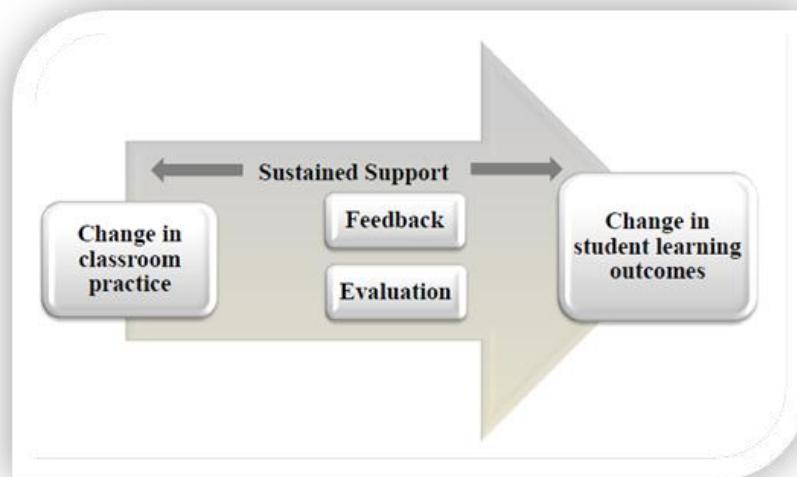


Fig. 2: A conceptual change model for CPD (source, after author)

Conceptual Model of Professional Development

Figure 4 presents a conceptual model for CPD informed by the above discussion and literature in the field. It synthesises teacher learning, the change process and motivational factors pertaining to effective CPD. Teachers’ experiences, knowledge and beliefs are rightly positioned at the start of this model. Cognitive dissonance, reflection, and professional learning activities, supported by the teacher educator, are fundamental elements of teacher learning.

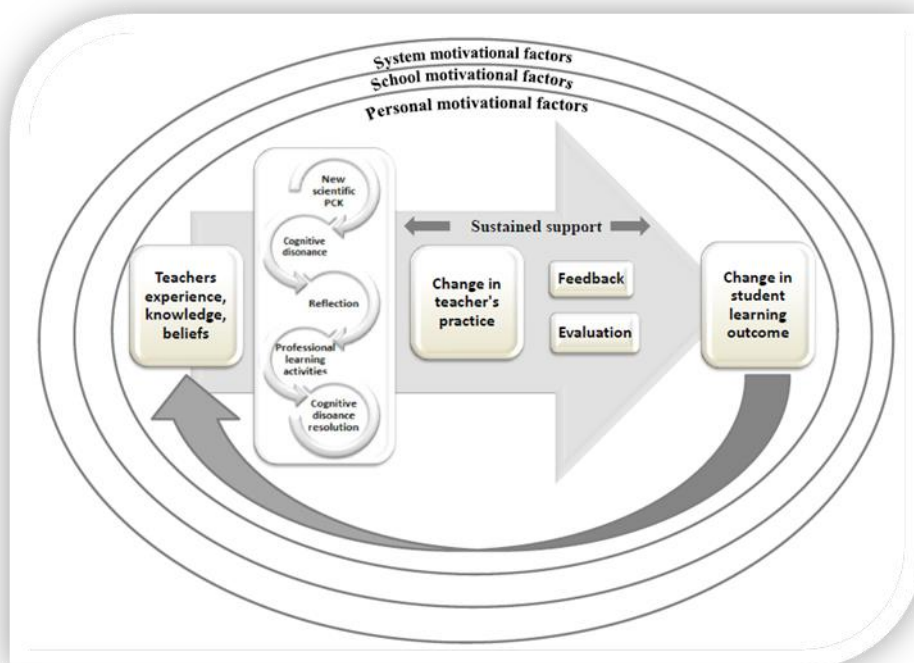


Fig.4: Conceptual model for teacher professional development (source, after author).

Teacher educators need to support teachers throughout the change process. When teachers have seen positive impact on pupil outcomes, the new practice becomes normalised allowing the teacher to concentrate on other things. Thus a continuous cycle of development is considered appropriate. Each time a goal is achieved a new cycle starts. This conceptual model should underpin future CPD programmes in science education.

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