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A Constructivist Framework for a Model of Short-term Professional Development for Science Teachers

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This is a synopsis of an Interactive Poster for the ICASE World Conference STE 2010. The study presented here relates to innovation through research into teaching and learning pertaining to science education.

Abstract
This poster presents a constructivist framework for a model of short-term professional development, which was offered to secondary school science teachers in Australia, Sri Lanka and Indonesia. Despite the popular view maintained in the literature, it was found that one-day workshops could be modelled on constructivist principles and can indeed facilitate conceptual change in the teachers. Based on observational data, interviews with the workshop designers and 38 teachers, it is possible to offer here a three-part constructivist framework for short-term professional development.

Introduction
Short-term professional development, in particular the one-day workshop, is the most popular model of in-service offered to science teachers. However, this model is widely criticized as piecemeal and ad hoc [1],[3]. It is believed, firstly, that one-day workshops are based on a deficit model. Professional development that remedies teachers' knowledge deficits is non-sustainable and unlikely to promote pedagogical change [8]. Second, Researchers are also sceptical about the capability of such single interventions to genuinely promote inquiry-based pedagogy. It is believed that "the single, *stand-alone* workshop… seems to have the least impact in improving teaching practice" [5, p.70].

The literature maintains that inquiry-based pedagogy is promoted best when professional development is modelled on Constructivist principles. It is argued that "if students are to be taught in a way that helps them construct their own knowledge, then teachers need to learn science in the same manner" [6, p.183]. Professional development based on Constructivist principles can help teachers to build meaningful and confident understandings about their scientific knowledge; offer opportunities to experience inquiry in practice; learn collaboratively from peers; and experience the uncertainties of student-centred inquiry [7].

However, the literature lacks studies which investigate the possibility of short-term professional development modelled on Constructivist principles. Only a few studies make some reference in this regard, but even these are not explicit in their findings. For example, one study states that short-term professional development "under certain conditions may have a long-term impact" [11, p.29]. The study calls this a "propelling effect". However, this premise has not been fully explored. In my poster, I present a Constructivist framework for the one-day workshop model.

Constructivist Framework
"Constructivism implies that (learners) require opportunities to experience what they are to learn…and make sense of that they are learning" [10, p.405]. Hence a Constructivist learning framework should promote active investigation and construction of knowledge that is meaningful

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to the learner [9]. A recent study identifies four critical criteria for a Constructivist framework: eliciting prior knowledge, creating cognitive dissonance, application of knowledge with feedback, and reflection on learning [2]. In the context of professional development programs it is essential also that "new ideas are intelligible, plausible, fruitful and feasible" if they are to be constructed meaningfully [12, p.57].

Methodology

The Centre for the Public Awareness of Science at the Australian National University offers one-day workshops to secondary school science teachers. These workshops draw science centre traditions of public engagement and employ easy to assemble simple demonstrations. To explore the possibility for short-term professional development to include a Constructivist framework, I investigated the above workshops based on the following research question:

Do short-term workshops that are based on Constructivist principles enable teachers to construct meaningful scientific knowledge and practicable understandings about science teaching?

I used data from three separate sources to investigate the research question:

(a) Interview data from workshop designers
(b) Interview data from teacher-participants
(c) Workshop observation data.

I triangulated this data using between-methods triangulation [4] to obtain an in-depth and comprehensive answer for the above question.

Results and discussion

(a) Interview data from workshop designers

The workshop designers' understanding about Constructivism was consistent with the literature. They emphasised the importance of examining existing knowledge, since many teachers held misconceptions about scientific concepts. The workshop designers believed that an important aim of the workshops was to help the teachers develop confidence to question their own scientific knowledge. To do this, it was important to offer the teachers learning experiences that were personally meaningful. This was achieved, the designers explained, by offering the teachers contextualised learning experiences based on simple demonstrations, group work and models of scientific inquiry. It was also important to allow opportunities to reflect on effective pedagogy by which to incorporate the teachers' newly-constructed knowledge to suit the needs of their classrooms.

(b) Interview data from teacher-participants

I interviewed a purposeful random sample of 38 teacher-participants, in total, from the workshops in Australia, Sri Lanka and Indonesia. The interviews were open-ended and based on a two-part format.

Part 1: *Did the workshops help the teachers to know more about science?*

All the teacher-participants agreed that the workshops had improved their scientific knowledge. To describe the workshops in their responses they used statements like "clarified our own thoughts and concepts", "deconstructed and made my knowledge manageable", and "enriched my scientific way of knowing".

Part 2: *How, according to the teachers, did the workshops improve their scientific knowledge?*

The teachers believed that the workshops addressed misconceptions in their scientific knowledge. They explained that the workshops helped to make personally meaningful links between everyday experiences and their scientific knowledge. They described the simple demonstrations used to conceptualise complex scientific understandings. Because of their familiarity with these experiences, they were able to construct knowledge more meaningfully. Sentiments of empowerment and ownership of their learning process were highlighted in those responses. The teachers added that workshop activities based on group-work fostered collegiality and a non-threatening learning environment.

(c) Workshop observation data

Based on Flanders Interaction Analysis System [4], I developed six categories (Cat.) of observational variables, which I used to record workshop observations:

Cat.1. Question causing teachers to reflect about their existing scientific knowledge
Cat.2. Statement informing teachers about the accuracy of their scientific knowledge
Cat.3. Reference informing teachers about a particular scientific concept
Cat.4. Activity informing teachers about a particular scientific concept
Cat.5. Reference that scaffolds teachers' newly-constructed scientific knowledge

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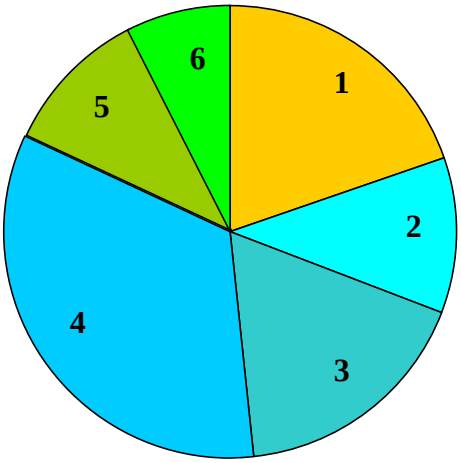
Cat.6. Demonstration that scaffolds teachers' newly-constructed scientific knowledge.

The frequencies of the six categories of observational variables were broadly consistent across the six workshops that I observed. They comprised relatively the same proportion of the total observations in each of those workshops. I calculated the percentage for each category based on the total number of observations in each of the six workshops (see Appendix 1). Fig. 1 shows the average of these percentages against each category.



Category	1	2	3	4	5	6
Average %	20	11	17	34	10	8

Figure 1. Averages of the percentages of the six categories of workshop observations.

Conclusions

It is possible to combine the observation data with interview data to locate three distinct stages that exemplify Constructivist principles within the workshops. These stages are given as follows.

To examine: Examine teachers' existing scientific knowledge (Cat.1; 20%)

To inform: Inform teachers' scientific knowledge - deconstructing misconceptions, building meaningful constructs and offering opportunities for active exploration (Cat.2, 3 & 4; in total 62%)

To scaffold: Scaffold teachers' newly-constructed scientific knowledge (Cat.5 & 6; in total 18%).

Based on these three stages it is possible to offer a Constructivist framework for the one-day workshop model of short-term professional development (see Fig. 2).

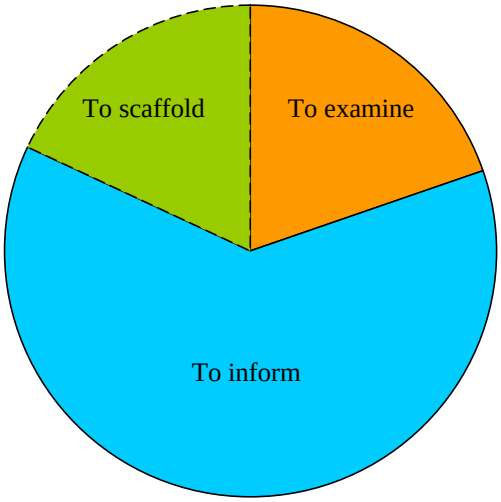


Figure 2. A Constructivist framework for a model of short-term professional development.

To scaffold teachers' newly-constructed scientific knowledge means to enable them to advance their knowledge in future. Therefore, that margin in Fig. 2 is denoted with a dotted-line, to represent this idea accurately (*i.e.* not a *closed* framework). It is intended that the above diagrammatic representation would serve as a framework for professional developers. This framework would facilitate the design and implementation of short-term programs based on Constructivist principles to develop science teachers professionally.

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Appendix 1

Frequencies of observations in each category expressed as percentages of the total frequencies in each of the six workshops

	Categories of workshop communications					
	1	2	3	4	5	6
Workshop 1	20.42	9.86	15.50	36.62	9.86	7.75
Workshop 2	18.03	11.48	18.85	33.61	12.30	5.74
Workshop 3	15.27	12.21	15.27	37.40	12.98	6.87
Workshop 4	20.55	13.01	16.44	33.56	10.27	6.16
Workshop 5	21.21	9.60	21.21	30.30	7.58	10.10
Workshop 6	22.37	10.50	18.26	30.59	9.13	9.13
Average	19.64	11.11	17.59	33.68	10.35	7.63

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