Effective Science Communication Practices and Simple Hands-on Activities: Two Important Elements of Teacher Professional Development

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Abstract. Inquiry-based pedagogy remains a key reform recommendation for school science internationally. Many science teachers are, however, challenged by inquiry. Mounting evidence suggests two main reasons for teachers’ reluctance towards this student-centred approach of instruction: a lack of a well grounded science knowledge base; and inadequate exposure to inquiry in practice. This paper presents qualitative evidence from Australian, Indonesian and Sri Lankan science teachers who participated in one-day professional development workshops that exemplified constructivist learning. The findings indicate that simple hands-on activities and effective science communication practices can help to foster inquiry.

Keywords: constructivism, hands-on, inquiry, professional development, science communication.

1. Introduction

The literature suggests that school science should yield outcomes beyond the confines of mere classroom learning [5], [8]. In fact, it is believed that school science is effective only when it is “linked with the broader community” [19, p.19] and when students are able to “generate fruitful and relevant questions and frame them in an effective way for investigation” [7, p.228]. Such a shift in emphasis, from traditional content-based instruction, requires science teachers to “focus more on the nature of science and on the evidence and arguments of scientific ideas, and help students develop skills of engaging in fruitful argumentation” [24, p.670]. Consequently, a key recommendation for science education reform internationally requires teachers in the classroom to emulate the investigative processes of scientific inquiry [13], [16], [17], [22].

Despite the onus placed on student-centred inquiry, recent studies reveal that recommended pedagogy fails to feature in many science classrooms [20]. Instead, it is reported that teachers continue to employ traditional models of content transmission [15]. While the absence of inquiry in most science classrooms is lamented [2], it is irrefutable that teachers’ reluctance to implement inquiry stems from the challenge it represents.

There are two predominating reasons for this reluctance. First, many teachers lack a well grounded science knowledge base with which to facilitate inquiry in the classroom. Second, only a few teachers have had sufficient exposure to scientific inquiry, and are aware of what it entails, to be able to use it in the classroom.

The lack of adequately developed knowledge about scientific concepts, particularly at tertiary level, is a deterrent to inquiry-based pedagogy. For example, it was found that 50% of Australian middle school science teachers did not have relevant university science qualifications [26]. This lack of well constructed knowledge structures is manifested in their disinclination towards inquiry. It also explains their discomfort to uncertainty, questioning and puzzlement that are inherent to inquiry-based pedagogy [4]. In such situations, it is reasonable for teachers to be prone to self-doubt [23], especially those who have not experienced science as a means of inquiring into the natural world [27].

Second, the limited exposure of teachers to inquiry at school and university prevents them from implementing pedagogical reform. In fact, their apprenticeship ingrains traditional models of teacher-centred instruction, dominated by content, which is far removed from inquiry-based pedagogy [14]. Many teachers teach as they have been taught [21], and if they are aware of inquiry-based pedagogy they remain oblivious about how to actually implement it in the classroom.

Professional development for teachers has long been used to complement education reform. Advocates insist that inquiry-based approaches that are grounded on constructivist learning experiences should also be employed in the professional development of teachers [17], [27]. This would enable teachers “to learn about science and science teaching with the same
methods and strategies as students should learn science in schools" [18, p.190]. This paradigm shift is deemed essential, as it would help teachers to construct confident understandings about science through personally meaningful learning experiences [10]. These understandings are necessary to implement inquiry-based pedagogy. Professional development based on inquiry would also offer teachers the opportunity to actively and collegially experience inquiry hands-on [6].

Studies fail to recognize, however, the potential for short-term professional development programs - essentially the one-day workshop model - to complement education reform. Only a few studies mention the possibility of exploring short-term professional development as a means to motivate teachers to adopt inquiry [18], [25]. This paper presents evidence from a qualitative study that explored this possibility.

2. Research study

The Centre for the Public Awareness of Science (CPAS) at the Australian National University, offers one-day workshops entitled “Creative Science Teaching Using Simple Materials” for secondary school science teachers in Australia and elsewhere. As their name implies, these workshops employ simple, readily-accessible equipment. They also draw on the science centre traditions of public engagement. Interviews with the workshop facilitators, early on in the study, confirmed that constructivist learning principles were used to design the workshop activities. I investigated six such workshops. I present here findings from interviews with a purposeful random sample of 38 teachers (19 Australian, 10 Sri Lankan, 9 Indonesian) who participated in those workshops.

I interviewed the teachers using a standardized open-ended interview format [11]. First, I asked them if they believed the workshops had informed their scientific understandings. The next series of questions probed how the workshops, if successful, informed those understandings.

3. Results and discussion

All 38 teachers agreed that the workshops informed their understandings. As two Australian teachers remarked:

“I came away with a really good package of stuff. And that wasn’t just sort of in-the-hand stuff, but in-the-head as well.”

“Yes it has benefited me because, obviously there are a few scientific concepts that I didn’t understand... the workshop has given me the mental tools, I guess, to be able to convey those concepts to the kids.”

It was evidenced from similar responses that the workshops succeeded in informing the teachers’ scientific understandings. Therefore, it was necessary to find out next how the teachers believed this was achieved in the workshops.

Interview findings highlighted two workshop features that played pivotal roles. The first of these, which all the teachers acknowledged, was the simple materials used in the workshop activities. They used words like “surprise”, “fascination” and “amazement” to describe these experiences. An activity known as the “Buoyancy see-saw” was described by one Sri Lankan as follows:

“I liked the two cups of water balanced on a strip of wood. When we put our fingers into the water we saw how pressure increased with depth. I was amazed how such a simple device could convey such a deep message.”

A reason behind the teachers’ appreciation of simple materials was their transferability to the classroom. In fact, it is believed that transferability of information should be an important element of teacher professional development [9]. As explained by an Indonesian teacher:

“Simple materials are easy to get and they are cheap... I think the students would be happy if we used simple materials. They would definitely be more interested in these than standard laboratory equipment that we normally use...”

As one Australian teacher explained further, simple materials are transferable because their workings are obvious to the students:

“I like hands-on stuff because you can actually see what happens. And I think it is the same with kids, they can see it happening.”

The teachers’ responses indicated that the simple hands-on activities informed their
scientific understandings in a similar way. As one Sri Lankan teacher remarked:

"The results of the experiments done that day were directly evident. All the experiments had definite observable results so it was possible to understand the fundamentals behind it."

The teachers agreed that in order to teach science, they need to be confident about their own understandings. As another Sri Lankan teacher commented, experiences with hands-on activities had enabled such a level of confidence:

"... I could only completely understand the concept involved when I was able to experience it for myself. Until then I cannot explain this phenomenon to the student. I myself have to comprehend it first."

Second, the teachers believed that effective science communication practices helped to inform their understandings during the workshops. In particular, their responses highlighted three such practices: use of narratives, simple dialogue-type delivery style, and animated communications.

The teachers believed that the use of anecdotes and stories rendered familiarity to the scientific concepts. In fact, a recent study states that narratives help to bridge between scientific and non-scientific speech [3]. As explained by one Australian teacher:

"I particularly remember what we were told about the movie Titanic, as a way of describing buoyancy... These stories of the real world helped to make links to science."

Also, there were two or three facilitators present at each of the workshops. The facilitators interacted with one another while presenting to the teachers. The teachers appreciated this style of dialogue, particularly the way in which the facilitators freely discussed scientific concepts and critiqued each other. They pointed out, moreover, that the facilitators’ dialogue-type delivery style was effective because they chose to use simple, easy to comprehend language. As one Australian teacher remarked:

"The level of dialogue seems a good mix of academic, but at the same time what a general lay person can speak. They could have spoken at a very theoretical level, but they chose not to."

The teachers found that the facilitators’ use of body language, voice intonation and theatrical devices animated their communications. By communicating science in such ways the facilitators conveyed ("almost infectiously" as one Australian teacher stated) their enthusiasm and passion for science. The Sri Lankan and Indonesian teachers, in particular, for whom English was a second language, appreciated the facilitators’ animated communications because they crossed language barriers. As one Indonesian teacher described:

"I know enough English to understand what was said, but the body language, gestures, the way they moved their hands and their facial expressions, with these things the message got through much better."

Eminent scientists, like Michael Faraday and Lawrence Bragg, have emphasised good delivery is paramount when communicating science to the public [1]. Their writings also recognise the importance of expression, simple language and simple experiments. In order to engage an audience, Faraday states that "it is necessary to pay some attention to the manner of expression. The utterance should not be rapid and hurried...but slow and deliberate, conveying ideas with ease from the lecturer and infusing them with clearness and readiness into the minds of the audience.” A more recent analysis of public physics lectures concur that narrative, visual-story and comprehensible language should form the framework of scientific discourses with the public [12]. The responses above, from teachers in the present study, indicated that science communication practices in the workshops played an important role in conveying scientific ideas effectively.

4. Conclusion

This study offers evidence that professional development courses which incorporate simple hands-on experiments can offer science teachers much needed exposure to inquiry-based learning. Teachers were able to construct personally meaningful understandings about science. They were, therefore, more confident about their own scientific knowledge. This study also showed that science communication practices played an important role in such learning environments. They helped to build a bridge between science and commonplace events, making science more personally relevant to the teachers. Science communication practices also helped to transcend language barriers in the workshops for Sri Lankan and Indonesian teachers. These benefits of effective science communication
practices should not be limited only to the professional development of teachers. Opportunities to explore the potential of science communication in formal science education in the classroom are also needed.

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6. References


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