Student co-generated analogies and their influence on the development of science understanding

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Certificate of authorship/originality

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signed: _____ Date: _____

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Publications and papers produced from this research

Publication

Aubusson, P. & Fogwill, S. (2006). Role play as analogical modelling in science. In P. Aubusson, A. G. Harrison & S. Ritchie (Eds.), *Metaphor and analogy in science education*. (pp. 93-104). Dordrecht: Springer.

Conference Papers

Fogwill, S. (2006, July 5-8). *Student generated analogies in high school physics.* Paper presented at the Australasian Science Education Research Association Conference, Canberra.

Fogwill, S. (2007, July 11-14). *Physics students generating analogies to develop and show understanding – is this quality teaching and learning?* Paper presented at the Australasian Science Education Research Association Conference, Fremantle.

Dedication

This thesis is dedicated to:

The students in my classes who engaged in the teaching experiment, and to those who went beyond, volunteering to participate more fully in the study. Without their support this research would not have been possible.

My three children; Catherine, David and Christopher, and to my wife Lynley, who have all provided much love, support and encouragement.

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Abstract

Science educators often use analogies to help students develop understanding, but successful learning where students develop their own analogies has rarely been reported (Harrison, 2006). This research sought to investigate how the co-generation of analogies influenced students' learning of science. It stemmed from the author's scholarly interest in helping students understand the more difficult science concepts through analogical activities. The use of analogies as tools for learning encourages students to build on what they already know and understand. This research was underpinned by a constructivist epistemology.

A pilot study was conducted and this led to the development of four research questions:

a. How do students develop analogies?
b. How does the co-generation of analogies influence student engagement with science?
c. Do students develop deep understanding through the co-generation of analogies?
b. How does a teacher support students in the co-generation of analogies?

The literature that underpins the theoretical framework for this study is drawn from two main areas. The first relates to learning science through the construction of meaning (Freyberg & Osborne, 1985) and the second relates to the nature of analogy (Gentner, 1983) and its use in learning science (Harrison & Treagust, 2006).

A teaching experiment methodology (Brown, 1992; Confrey & Lachance, 2000) suited this study of learning through analogy in school science because it provides a sound framework for a teacher exploring and scrutinising a teaching approach with his own students during the course of regular timetabled lessons. A large amount and variety of data were collected during 24 episodes of the teaching experiment. The teaching experiment involved the application of a teaching intervention with senior high school, chemistry and/or physics students (16–18 years of age). The intervention required students to develop analogies with the purpose of showing and enhancing their understanding of science concepts. Throughout each application of intervention students were supported by each other and by the teacher.

The analogy based activities included role play, model building and writing. The discussions that occurred throughout these activities were integral to the analogy refining process. Hence, the resulting analogies were co-generated.

The following conjecture was qualitatively investigated using participatory enquiry.

When students develop their own analogies (supported by their teacher) in the process of learning science, they will be able to demonstrate deep understanding about the concepts being studied.

This conjecture was founded in the literature; supported by personal experience and a pilot study; and tested through several teaching episodes.

A large amount and variety of data were collected during the teaching experiment. These data have been used in providing "rich" (detailed) (Denzin & Lincoln, 2008, p. 16) and "thick" (based on multiple perspectives) (Lincoln & Guba, 1985, p. 316) descriptions of 13 episodes in which students developed their own analogies while learning science. Similar episodes have been grouped together and presented in five vignettes.

Findings from the vignettes have been used to formulate conclusions. Data from the episodes reveal that in general, students who participated in the intervention enjoyed becoming actively engaged in analogical learning.

In all applications of the intervention the majority of students were able, with support, to develop and use their own analogies to foster and display appropriate deep understandings about complex science concepts. By developing, using and sharing analogies, students made their conceptions and misconceptions 'visible'. In the supportive classroom environment, the identification of and discussion about students' alternative conceptions and misconceptions assisted students to develop appropriate scientific understandings. In general the understandings developed were persistent over long periods of time.

The data suggests that co-generating analogies enhances student engagement and leads to deep understanding of challenging science concepts. It is thus concluded that the co-

generation of analogies for science phenomena contributes positively to students' learning in science.

Key Words

Alternative conception, analogy, base, co-construction, engagement, episode, FAR guide, intervention, mapping, metaphor, misconception, model, relation, representation, role play, scholarly teacher, target, teacher/researcher, teaching experiment, understanding, vignette.