

# 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**

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## **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.

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# Table of Contents

Certificate of authorship/originality .....	i
Acknowledgements .....	ii
Publications and papers produced from this research .....	iii
Dedication .....	iv
List of Figures .....	viii
List of Tables.....	x
Abstract .....	xi
Key Words .....	xiv
Chapter 1 .....	1
1.1 Introduction .....	1
1.2 Background .....	2
1.3 Nature and scope of the study .....	5
1.4 An analogy for the photoelectric effect.....	6
1.5 Purpose .....	11
1.6 Significance .....	11
1.7 Overview of the thesis.....	16
Chapter 2 .....	18
Literature Review.....	18
2.1 Chapter Overview .....	18
2.2 The nature of analogy.....	18
2.3 Student's developing analogies while learning science .....	31
2.4 Analogies and constructivist learning theory.....	35
2.5 The learning of difficult concepts in science .....	39

2.6 The call for research.....	41
2.7 Frameworks for using analogies in teaching science .....	45
2.8 Conclusion .....	50
Chapter 3 .....	52
Methodology .....	52
3.1 Chapter overview .....	52
3.2 Background .....	52
3.3 Teaching experiments .....	55
3.4 Designing the activities .....	59
3.5 Site and context of the research.....	65
3.6 Data .....	66
3.7 Trustworthiness .....	75
3.8 Data Analysis .....	89
3.9 Reporting the study .....	96
3.10 Limitations .....	96
3.11 Ethics .....	99
3.12 Conclusion .....	101
3.13 Summary .....	102
Chapter 4 .....	104
Data Analysis .....	104
4.1 Chapter Overview .....	104
4.2 Introduction .....	104
4.3 Pilot Study-The extraction of copper from copper carbonate .....	107
4.4 Reflection of light.....	127
4.5 Medical Imaging Techniques .....	153

4.6 A model for a solenoid valve .....	198
4.7 The photoelectric effect .....	217
4.8 Summary .....	243
Chapter 5 .....	245
How the co-generation of analogies influences students' learning of science.....	245
5.1 Preamble .....	245
5.2 Findings .....	247
5.3 Implications.....	258
5.4 Refining our knowledge of analogy for science teaching and learning .....	259
5.5 Further research.....	263
5.6 Conclusion .....	265
REFERENCES.....	267
Appendix 1   Consent Form.....	285
Appendix 2a   Science Activity Questionnaire .....	286
Appendix 2b   Science Activity Questionnaire (rev.).....	288
Appendix 3   Interview Questions .....	290
Appendix 4   Codes .....	291
Appendix 5   Lesson coding sheet .....	292
Appendix 6   Student question sheet (reflection) .....	293
Appendix 7   Photoelectric effect explained.....	294
Appendix 8   DET ethics approval requirements .....	295
Key Terms .....	296

# List of Figures

<u>Figure</u>		<u>Page</u>
Fig. 2.1	Analogy - a continuum of classification	23
Fig. 3.1	Schematic showing the methodological position of this research	58
Fig. 3.2	This research has a vast amount of data from multiple methods	82
Fig. 4.3.1	Student 1 Response – Extraction of copper	109
Fig. 4.3.2	Student 2 - Response – Extraction of copper	110
Fig. 4.3.3	Student 3 - Response – Extraction of copper	111
Fig. 4.3.4	Yr 11 students demonstrating calcium carbonate	113
Fig. 4.3.5	Survey data for the Pilot Study	116
Fig. 4.3.3	Thankyou card – Student artefact – SA-230904-S5	126
Fig. 4.4.1	Candle and its reflection in a mirror (Photo taken by author)	129
Fig. 4.4.2	Student sketch of the reflection from a candle as seen from an angle in a mirror located in a dark room (SA180506RP-11Ph)	130
Fig. 4.4.3	(V1-V12) Series of phone video captures-Reflection Role play	132-136
Fig. 4.4.4	Group One being observed by another teacher	139
Fig. 4.4.5	The student on the right is demonstrating that multiple flame images can be seen only from a side-on position	140
Fig. 4.4.6	Group Two (2007) Working on the idea that light bounces back and forth between a mirror and a layer of “artificial atmosphere” composed of carbon dioxide that surround the flame.  (Student comment-V170307-11Ph-RP –Reflection)	141
Fig. 4.4.7	(a) Demonstrating the removal of a sheet of aluminium from the back of a mirror and (b) showing the thickness of the mirror’s glass	142
Fig. 4.4.8	(a)-(g) Student’s diagram to explain how information is sent through an optical fibre (SA180506-11Ph-RP – AE-H).	147-150
Fig. 4.5.1	Year 12 students (S1 & S2) developing a short role play about a gamma scan.	155
Fig. 4.5.2	Year 12 students (S1, S2 & S3) performing a short role play about a gamma scan.	157
Fig. 4.5.3	Yr 12 students (S4, S5 & S6) role playing the use of Tc99m in gamma scanning.	158

Figure		Page
Fig. 4.5.5	Group One rehearsing a short role play to demonstrate how some ultrasound energy is reflected from a tissue boundary while the rest is transmitted into the tissue.	161
Fig. 4.5.6	Group Two students having fun whilst drafting a role play about the reflection of ultrasound	162
Fig. 4.5.7	(a) & (b) Doppler Ultrasound demonstrations	163
Fig. 4.5.8	Five students in a laboratory, actively discussing how to role play an aspect of MRI.	165
Fig. 4.5.9	Annotated images from a short role play about MRI (VT-200905-RP-Ph)	181-183
Fig. 4.6.1	Students mapping magnetic fields (V-170605-M-11Ph)	199
Fig. 4.6.2	Typical student response to “Draw a solenoid and describe what happens when it is turned on” SA-290606-M-11Ph-S5.	201
Fig. 4.6.3	Student proudly showing his initial sketch of a possible solenoid valve design to the camera. (V-290606-M-11Ph)	203
Fig. 4.6.4	Students collecting materials for their model solenoid valves (V-290606-M-11Ph)	205
Fig. 4.6.5	Group 05-S building a model solenoid (V-170605-M-11Ph)	206
Fig. 4.6.6 (a)	Group 05-E testing an idea (b) Group 05-E’s more refined model (V-170605-M-11Ph)	206
Fig. 4.6.7	(a) Solenoid on-tap open (b) Solenoid off-tap closed (V-170605-M-11Ph)	207
Fig. 4.6.8	Group 05-K/N Solenoid model – diagram	208
Fig. 4.6.9	A model that used gravity (V-170605-M-11Ph)	208
Fig. 4.6.10	Two groups working on their model solenoid valves (2006) (V-290606-M11Ph)	209
Fig. 4.6.11	(a) Students adjusting their model (b) The solenoid turned on	213
Fig. 4.6.12	Diagram for Students response (1)	215
Fig. 4.6.13	Diagram for Students response (2)	216
Fig. 4.7.1	Student’s mapping table for a photoelectric analogy SA-130606A-CF-12PH	231
Fig. 4.7.2	Diagrams from students’ answers to an examination question about the photoelectric effect. SA-092006-THSC-Q30(c).	238

# List of Tables

<u>Table</u>		<u>Page</u>
Table 1.1	Mapping attributes and relations in an analogy for the photoelectric experiment	10
Table 2.1 –	Analogy Terms	21
Table 2.2	Studies about students generating analogies	34
Table 2.3	Comparison of models of teaching with analogies	49
Table 3.1	Record of episodes presented in Chapter 4	71
Table 3.2	Episodes conducted but not formally reported on in Chapter 4 of the Thesis	72
Table 4.1	ANOVA: single factor comparison between two Year 11 Physics classes' understanding of multiple image formation from a candle reflection displayed in written answers completed under test conditions 5/6 weeks after the intervention.	152
Table 4.6	Responses to questions asked during the Focus Phase of the Solenoid Modelling episode in 2006 (SA20060611Ph)	202
Table 4.7	Optional responses to the Questionnaire (SA- 080606-A-12Ph)	232
Appendix 4	Codes used to identify data collected during this research.	291

# **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.