2008

Teaching secondary science with data loggers: the NSW experience

Kenneth R. Silburn
University of Wollongong

UNIVERSITY OF WOLLONGONG

COPYRIGHT WARNING

You may print or download ONE copy of this document for the purpose of your own research or study. The University does not authorize you to copy, communicate or otherwise make available electronically to any other person any copyright material contained on this site. You are reminded of the following:

This work is copyright. Apart from any use permitted under the Copyright Act 1968, no part of this work may be reproduced by any process, nor may any other exclusive right be exercised, without the permission of the author.

Copyright owners are entitled to take legal action against persons who infringe their copyright. A reproduction of material that is protected by copyright may be a copyright infringement. A court may impose penalties and award damages in relation to offences and infringements relating to copyright material. Higher penalties may apply, and higher damages may be awarded, for offences and infringements involving the conversion of material into digital or electronic form.

Unless otherwise indicated, the views expressed in this thesis are those of the author and do not necessarily represent the views of the University of Wollongong.

Recommended Citation


Research Online is the open access institutional repository for the University of Wollongong. For further information contact the UOW Library: research-pubs@uow.edu.au
Teaching secondary science with data loggers: the NSW experience

Kenneth R. Silburn
University of Wollongong


This paper is posted at Research Online.
NOTE

This online version of the thesis may have different page formatting and pagination from the paper copy held in the University of Wollongong Library.

UNIVERSITY OF WOLLONGONG

COPYRIGHT WARNING

You may print or download ONE copy of this document for the purpose of your own research or study. The University does not authorise you to copy, communicate or otherwise make available electronically to any other person any copyright material contained on this site. You are reminded of the following:

Copyright owners are entitled to take legal action against persons who infringe their copyright. A reproduction of material that is protected by copyright may be a copyright infringement. A court may impose penalties and award damages in relation to offences and infringements relating to copyright material. Higher penalties may apply, and higher damages may be awarded, for offences and infringements involving the conversion of material into digital or electronic form.
Teaching secondary science with data loggers:
the NSW experience

A thesis submitted in partial fulfillment of the
Requirements for the award of the degree

Doctor of Education
from

University of Wollongong
by

Kenneth Raymond Silburn
BSc (Macquarie), Grad Dip Ed (Sydney CAE), MEd (UWS)

Faculty of Education
2008
Teaching secondary science with data loggers: the NSW experience

Candidate: Ken Silburn
Student number: 9838639
University of Wollongong
Research Thesis for the Doctor of Education Degree

Supervisors: Dr. Brian Ferry
Dr. Sue Bennett

Date of Submission: 8 October 2008
Research Thesis for Doctor of Education degree

Teaching secondary science with data loggers: the NSW experience

Candidate: Ken Silburn
Student number: 9838639
University of Wollongong
7.2.1 How do teachers currently use data loggers with their students in physics classrooms?

Current usage rates ........................................................................................................ 207
Impact of types of data loggers .................................................................................. 209
Rationale for using data loggers .................................................................................. 209
Perceived benefits of data loggers ............................................................................... 211
Impact on student learning ......................................................................................... 211
Teachers’ attitudes ....................................................................................................... 215
Students’ attitudes ....................................................................................................... 215

7.2.2 What factors influence teachers’ use of data loggers? ............................................ 217
New technology and complexity .................................................................................. 217
Syllabus issues .............................................................................................................. 218
Teacher confidence ....................................................................................................... 218
Professional development and teacher training .......................................................... 218
TILT training .................................................................................................................. 220
DET Consultants .......................................................................................................... 221
Teacher experience (community of practice) .............................................................. 222
Workload and time ....................................................................................................... 221
Equipment and classroom management issues .......................................................... 222

7.2.3 What are the implications for integrating data loggers into the science curriculum? 224
Providing adequate resources ...................................................................................... 225
Type of data logger and purchasing ............................................................................. 227
Teacher professional development .............................................................................. 227
Policy ............................................................................................................................. 228

7.3 Suggestions for further research ............................................................................. 229

7.4 Conclusions and implications for practice ............................................................. 229

References .................................................................................................................... 231

Appendix 1: Pilot study student survey ......................................................................... 240
Appendix 2: Results of pilot student survey ................................................................. 241
Appendix 3: Student survey modification and application .......................................... 243
Appendix 4: Modified student survey ........................................................................... 245
Appendix 5: Pilot study teacher survey ......................................................................... 247
Appendix 6: Elaboration of pilot teacher survey ........................................................... 249
Appendix 7: Modified teacher survey .......................................................................... 251
Appendix 8: Teacher survey ......................................................................................... 253
Appendix 9: Teacher interview questions ..................................................................... 256
Appendix 10: Student interview questions .................................................................... 257
Appendix 11: Business interview questions .................................................................. 258
Appendix 12: Observation protocol ............................................................................. 259
Appendix 13: DET ethics request ................................................................................. 260
Appendix 14: DET ethics approval ............................................................................... 261
Appendix 15: UOW ethics approval ............................................................................. 262
Appendix 16: Information sheet principal ..................................................................... 263
Appendix 17: Consent form principal ........................................................................... 265
Appendix 18: Information sheet teacher ....................................................................... 266
Appendix 19: Consent form teacher ............................................................................. 267
Appendix 20: Information sheet student ....................................................................... 268
Appendix 21: Consent form student ............................................................................. 269
Appendix 22: Information sheet parent ........................................................................ 270
Appendix 23: Information sheet Marker (surveys) ....................................................... 271
Declaration

I, Kenneth Raymond Silburn, declare that this thesis, submitted in partial fulfilment of the requirements for the award of Doctor of Education, in the Faculty of Education, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other institution.

Ken Silburn
Date 8 October 2008
Acknowledgements

The completion of this thesis would not have been possible without the assistance of a number of people. It is not something that could have been accomplished in isolation.

I am deeply indebted to my supervisors, Professor Brian Ferry and Doctor Susan Bennett whose expert guidance, clear direction, and thoughtful encouragement I have benefited from throughout the course of my doctoral undertaking.

My thanks, too, go to my colleagues who teach science in the classrooms of western Sydney, without whose responses to the surveys, interviews, classroom visits and myriad conversations, this thesis would not have been possible.

I would also like to thank Bernie Fitzpatrick for his assistance in reviewing the draft of this thesis.

To my parents, Ted and Hazel, who have always been interested in what I do and supportive of my love for learning: thank you for the many sacrifices that are now clear to me, and also for instilling in me the value of knowledge and a passion for excellence.

Last, but certainly not least, I wish to thank my family, Jan, Jacqui, Alan, David and Bradley for putting up with the constant distraction of study and the long periods of time that I spent adhered to the computer.
Abstract

Many countries have identified an urgent need to revitalise the way science is taught in secondary schools in an endeavour to increase the number of students electing to study science at senior school and continuing into science-related study at university.

Recent changes to the New South Wales Higher School Certificate Stage 6 Science syllabuses have resulted in a shift towards the use of data acquisition and analysis technology in the science laboratory. Combined with the increase in technology available to schools and the decrease in cost associated with its use, data acquisition equipment and analysis software, such as data loggers, are now seen as an essential part of the science curriculum.

The recent introduction of data loggers into the education system has been implemented despite a lack of empirical research into their effective use. This study addresses this gap in literature by investigating the implementation and use of data loggers in the secondary science classroom from the viewpoint of both students and teachers.

The purpose of the study was to describe how teachers use data acquisition and analysis technology to support student learning in secondary physics. The study also sought to develop descriptions of effective practice in the use of data loggers in secondary physics teaching and also identified the purposes of the different approaches taken by teachers. An anticipated outcome of this research is an improved understanding of how teachers can better facilitate increased student learning through the use of appropriate technology in the classroom.

The study was guided by three key questions:
(1) What is the current impact of data loggers in secondary school physics classrooms?
(2) What factors influence the ways teachers use data loggers with their classes?
(3) What are the implications for integrating data loggers into the physics curriculum?
A mixed method design combining qualitative and quantitative approaches including a combination of survey, interviews and case study research methods was used. Data were collected by surveys and interviews with students and teachers, and classroom observations. Student focus group interviews were carried out under supervision of an appropriate adult, in consultation with the principal.

The study incorporated the researcher’s own school as well as nine other schools in the Campbelltown and Liverpool School Districts of Sydney, New South Wales. Professional people identified as being leaders in the area of data logging and education also were interviewed to triangulate findings from the schools.

The study found that despite the rhetoric exalting their virtues, the implementation of data logger use in NSW schools has not been effective. Survey results indicated that data loggers were almost only used in the senior years of high school. Even though many teachers could identify the advantages of using data loggers in their classes they were not confident in using this technology, and cited a lack of professional development, the cost and scarcity of equipment, and the complexity and problems associated with classroom management of such equipment.

The study also identified cases of best practice and highlighted strategies used by teachers to use data loggers to extend students’ knowledge. The findings have implications for the future implementation of data loggers in schools and suggest avenues for further research.
List of tables
Table 2-1 Comparison of related search criteria for the period 1990-2004 28
Table 2-2 An elaboration of the 5Es teaching and learning model. (Australian Academy of Science 2007) 46

Table 3-1 Greene, Caracelli and Graham’s List of Purposes for Mixed Research (Greene, Caracelli et al. 1989) as in Johnson and Christensen (Johnson and Christensen 2004). 66
Table 3-2 Sequence and timeline 67
Table 3-3 Teachers interviewed 76
Table 3-4 Data collection techniques used in the study 83
Table 4-1 Teacher survey data 86
Table 4-2 Analysis of data from Question 1.1 87
Table 4-3 Analysis of data from Question 1.2 88
Table 4-4 Analysis of data from Question 1.3 88
Table 4-5 Summary of data for Question 1.4 89
Table 4-6 Use of data loggers in the senior classes (Years 11 and 12, 2001-2003) 89
Table 4-7 Summary of data for Question 2.1 (n= 61). 89
Table 4-8 Comparison of confidence in using data loggers to previous years 90
Table 4-9 Summary of data for question 2.3 (n= 63) (2003). 92
Table 4-10 Comparison to previous years 92
Table 4-11 Rubric for determining the level of use of data loggers 93
Table 4-12 Selected responses to question 2.3a (2003) 94
Table 4-13 Level of use of data loggers by teachers (2003) 94
Table 4-14 Summary of data collected for question 2.4 96
Table 4-15 Summary of data for Question 3.1 97
Table 4-16 Summary of data for Question 3.3 (N= 47) 100
Table 4-17 Summary of teacher attitude to the use of data loggers (2003) 106
Table 4-18 Summary of data for question 3.2 108
Table 4-19 Summary of data for question 3.3 109
Table 4-20 Results of curriculum consultants workshop 115
Table 5-1 Student survey data 122
Table 5-2 Analysis of Question 3 123
Table 5-3 Analysis of data from Question 3 123
Table 5-4 Analysis of data from Question 4 124
Table 5-5 Analysis of data from Question 5 124
Table 5-6 Analysis of data from Question 9 127
Table 5-7 Analysis of data from Question 10 127
Table 5-8 Analysis of data from Question 11 128
Table 5-9 Analysis of data from Question 12 129
Table 5-10 Analysis of data from Question 13 131
Table 6-1 Characteristics of participating schools 168
List of figures

Figure 2-1: Percentage of students selecting science subjects 1997-2005. Source: NSW Board of studies. (NSW Board of Studies, 2001; NSW Board of Studies, 1998; NSW Board of Studies, 1999; NSW Board of Studies, 1997; NSW Board of Studies, 2002; NSW Board of Studies, 2003; NSW Board of Studies, 2005; NSW Board of Studies, 2000; NSW Board of Studies, 2004) 31

Figure 2-2: Percentage of students selecting physics 1976–2002. Source: Australian Council for Educational Research (Masters, 2006) 32

Figure 2-3: Percentage of students selecting chemistry 1976–2002. Source: Australian Council for Educational Research (Masters, 2006). 33

Figure 2-4: Percentage of students selecting biology 1976–2002. Source: Australian Council for Educational Research (Masters, 2006) 33

Figure 2-5: Student retention rates (Centre for Epidemiology and Research, 2003). 35

Figure 2-6: A diagrammatic representation of the path through a recipe task (Ash & Buchanan, 1998). 44

Figure 2-7: A restructured laboratory task that requires learners to plan, design, evaluate, perform and re-evaluate their work (Ash and Buchanan 1998) 45

Figure 3-1: Schematic overview of the study 68

Figure 3-2: Participants and data collection techniques used 72

Figure 6-1: Example of experimental results collected. 182

Figure 7-1: Visual representation of teacher data logging. 213