Copyright is owned by the author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the author.
AN EXPLORATION OF SCIENCE LECTURERS' VIEWS ON QUALITY TEACHING IN SCIENCE AT UNIVERSITY

A thesis presented in partial fulfilment of the requirements

for the degree of

Doctor of Philosophy

in Education

at Massey University, Palmerston North,

New Zealand

Janet Zoe Jordens 2019
ABSTRACT

Undergraduate university students learn science in ways that are different to those used in professional science laboratories and do not prepare them for their work as practising scientists. This study aimed to explore lecturers’ views on quality teaching and learning in science and what influenced their views and practice.

I developed a theoretical framework of sensitising lenses based on quality as a complex system and wicked problem, to explore science lecturers’ views on quality teaching and learning in undergraduate science. This framework, together with key ideas from complexity thinking, guided all aspects of the research. The research design was a multistage mixed methods approach consisting of a dissensus Delphi study followed by a large-scale survey and semi-structured interviews.

The problem definition, openness and social complexity lenses identified characteristics that science lecturers associated with quality teaching and learning in undergraduate science. Quantitative data revealed views with varying extents of consensus on these characteristics. Based on these views I proposed a transformative framework for understanding quality teaching and learning in undergraduate science in which generic principles of good teaching are embedded in ways of thinking and practising in science, social relationships are promoted, and variable cultural and sub-discipline factors are included according to the specific context. From this, quality could be viewed as a complex system (rather than a wicked problem) and conditions for its emergence proposed.

The non-linearity and multiple-causality lenses identified influences affecting lecturers’ quality teaching. These showed the main driver of lecturers’ changing their teaching was reflective practice, with student feedback the main contributor to this. However, findings from quantitative data showed many characteristics associated with quality teaching were implemented less often than expected, suggesting reflective practice was underutilised. I suggest the potential gap between reflective practice and action is teacher agency. With the aid of the problem resolution lens, I propose a conceptual framework for quality teaching in undergraduate science that has the potential for the
emergence of quality from a complex system, and recommend actions for lecturers, educational development and institutions to help achieve this potential.
ACKNOWLEDGEMENTS

I would like to thank my supervisors Nick Zepke, Linda Leach and Peter Rawlins for the opportunity to pursue the research. Your support and encouragement made this intellectual journey possible.

I thank my family for tolerating ‘Mrs Grumpy’, especially during the protracted writing-up phase.

I am extremely grateful for financial support for the research from the following: Institute of Education, Massey University; Institute of Fundamental Sciences, Massey University; and Ako Aotearoa.

Most of all, I thank the science lecturers who gave their time in contributing their views, without you this research would not have been possible. I am especially grateful to members of the Delphi panel including: Gary Bold, Juliet Gerrard, Kevin Gould, Judy Magee, Derek Moot and Michael Walker.
## CONTENTS

ABSTRACT .................................................................................................................................. I

ACKNOWLEDGEMENTS ....................................................................................................... III

CONTENTS ................................................................................................................................ V

LIST OF FIGURES ................................................................................................................... IX

LIST OF TABLES ..................................................................................................................... XI

CHAPTER 1: INTRODUCTION .......................................................................................... 13
  1.1 My background and interest in this topic ..................................................... 13
  1.2 Undergraduate science teaching and quality ............................................. 14
  1.3 Aims of the Research ................................................................................... 18
     1.3.1 Research Questions ............................................................................. 18
  1.4 Overview of the thesis ................................................................................. 19

CHAPTER 2: LITERATURE REVIEW .............................................................................. 21
  2.1 Introduction ................................................................................................ 21
  2.2 Quality in higher education ........................................................................ 21
     2.2.1 Quality is a contested notion ............................................................. 21
     2.2.2 University lecturers’ views of quality ................................................ 25
     2.2.3 Quality is a complex problem ........................................................... 27
  2.3 Quality teaching and learning ..................................................................... 32
     2.3.1 Student learning .................................................................................. 32
     2.3.2 Relationship between learning, teaching and the role of the lecturer ....... 37
     2.3.3 Teaching and learning in science ....................................................... 45
     2.3.4 Science lecturers’ views of quality teaching and learning ................. 48
  2.4 Other influences on lecturers teaching ...................................................... 51
  2.5 Conclusion .................................................................................................. 52

CHAPTER 3: METHODOLOGY AND METHODS .......................................................... 53
  3.1 Introduction ................................................................................................ 53
  3.2 Research Methodology .............................................................................. 53
     3.2.1 Research question-led research ......................................................... 54
     3.2.2 Selecting the mixed methods research design ....................................... 63
     3.2.3 Data analysis ...................................................................................... 71
     3.2.4 Legitimation ....................................................................................... 72
     3.2.5 Ethical considerations ....................................................................... 75
     3.2.6 Methodology summary ................................................................. 76
  3.3 Methods ..................................................................................................... 79
3.3.1 Ethical considerations ................................................................. 79
3.3.2 Data collection ........................................................................ 81
3.3.3 Data analysis ........................................................................... 83
3.3.4 Methods summary .................................................................. 86

CHAPTER 4: DELPHI STUDY FINDINGS ............................................. 87

4.1 Introduction .................................................................................. 87
4.2 What do national award-winning tertiary teachers consider to be quality
   teaching and learning in undergraduate science? .............................. 88
   4.2.1 Round 1: panel members’ views on quality teaching, learning and
         preparation for working in science ................................................ 88
   4.2.2 Round 2: discerning the extent of consensus on characteristics associated
         with quality teaching .................................................................... 91
   4.2.3 Round 3: refining statements on quality teaching ....................... 100
4.3 What are the main influences on lecturers’ teaching and learning? .... 104
   4.3.1 Quality as change ..................................................................... 104
   4.3.2 Quality as influence ................................................................. 105
4.4 Chapter summary ......................................................................... 106

CHAPTER 5: LECTURER SURVEY FINDINGS ..................................... 108

5.1 Introduction .................................................................................. 108
5.2 Survey participants’ demographics .............................................. 108
   5.2.1 Response rate ........................................................................ 108
   5.2.2 Demographics ........................................................................ 109
5.3 What do a larger sample of university science lecturers consider to be quality
   teaching and learning in undergraduate science? .............................. 113
   5.3.1 Statistical analyses of quantitative survey data ......................... 113
   5.3.2 Analyses of qualitative survey comments with the lenses .......... 126
5.4 What are the main influences on lecturers’ teaching and learning? .... 133
   5.4.1 Quality as change ..................................................................... 133
   5.4.2 Quality as influence ................................................................. 134
5.5 Chapter summary ......................................................................... 135

CHAPTER 6: LECTURER INTERVIEW FINDINGS ............................... 137

6.1 Introduction .................................................................................. 137
6.2 Interviewee demographics ........................................................... 137
6.3 What do a larger sample of university science lecturers consider to be quality
   teaching and learning in undergraduate science? .............................. 141
   6.3.1 The problem with defining quality teaching in undergraduate science .. 141
   6.3.2 Quality as openness ................................................................. 146
   6.3.3 Quality as relationship ............................................................ 153
6.4 What are the main influences on lecturers’ teaching and learning? .... 156
   6.4.1 Quality as change ..................................................................... 156
6.4.2 Quality as influence: supporting influences ................................................. 158
6.4.3 Quality as influence: concerns...................................................................... 161

6.5 Chapter summary ...................................................................................... 163

CHAPTER 7: INTEGRATION OF FINDINGS ............................................................... 165
7.1 Introduction .............................................................................................. 165
7.2 What do science lecturers consider to be quality teaching and learning in undergraduate science? ........................................................................................................ 165
   7.2.1 The problem with defining quality teaching in undergraduate science ..... 165
   7.2.2 Variation in extent of consensus ............................................................. 167
   7.2.3 Quality as openness and relationships ..................................................... 171
7.3 What are the influences on lecturers’ quality teaching? ............................. 172
   7.3.1 Quality as change ......................................................................................... 172
   7.3.2 Quality as influence ...................................................................................... 173
7.4 Chapter summary ...................................................................................... 175

CHAPTER 8: DISCUSSION .............................................................................................. 177
8.1 Introduction .............................................................................................. 177
8.2 Quality is viewed in multiple ways............................................................. 177
8.3 The need for a transformative perspective of quality .................................... 178
   8.3.1 Generic and science specific skills are essential for quality teaching and
         learning in science ........................................................................................ 178
   8.3.2 Quality in teaching and learning in science is context-dependent .......... 180
8.4 Quality in science teaching and learning as a complex system ................. 184
   8.4.1 System components are interrelated......................................................... 184
8.5 Multiple influences affect lecturers’ teaching ............................................ 187
   8.5.1 Lecturers’ reflective practice drives teaching change................................. 187
   8.5.2 Lecturers’ teaching is hindered by institutional cultures and bureaucracy. 189
   8.5.3 Lecturers’ teaching is enhanced when supported by heads of department,
         institutional recognition and educational development ................................ 190
8.6 A conceptual framework for the emergence of quality ................................ 193
   8.6.1 Lecturers’ reflective practice needs to be transformed into action .......... 193
   8.6.2 Reflective practice and action: teacher agency is the missing link .......... 195
8.7 Chapter summary ...................................................................................... 201

CHAPTER 9: RECOMMENDATIONS AND CONCLUSION ........................................ 202
9.1 A brief recap of the study .......................................................................... 202
9.2 Addressing the research questions ............................................................ 203
9.3 Contribution to knowledge ........................................................................ 204
9.4 Limitations of the research ........................................................................ 205
9.5 Recommendations .................................................................................... 206
LIST OF FIGURES

Figure 1. A diagrammatic representation of national quality systems. .......................... 23
Figure 2. Comparison of conventional thematic-based analyses (A) and complexity-based analyses (B). ......................................................................................................................... 30
Figure 3. The complexity continuum showing complex systems near the edge of chaos. ................................................................................................................................. 31
Figure 4. Conceptual framework indicating influences on student learning. ............... 38
Figure 5. Quality as a complex system. ........................................................................ 59
Figure 6. Typology of the multiphase design in Morse notation. .............................. 65
Figure 7. Summary of my multistage research design. ............................................. 77
Figure 8. Delphi study Round 2 responses to the question ‘Students learn science by . . . ’. ................................................................................................................................. 93
Figure 9. Delphi study Round 2 responses to the question ‘Quality teaching in science at university means . . . ’ ................................................................................................. 95
Figure 10. Delphi study Round 2 responses to the question ‘Current methods of teaching science prepare students WELL/POORLY for the wider world of using science/working in the science field because . . . ’ .......................................................... 98
Figure 11. Delphi study Round 3 responses to the survey on quality teaching in science. ................................................................................................................................. 101
Figure 12. Frequency of lecturer survey responses by university............................ 110
Figure 13. Lecturer survey responses by discipline.................................................. 110
Figure 14. Distribution of responses by university and grouped discipline for universities with a minimum of 20 participants ......................................................... 111
Figure 15. The university teaching experience of participants. ............................... 112
Figure 16. The preassigned ethnic groups with which participants identified on the survey (left)......................................................................................................................... 113
Figure 17. The relative frequency of responses to the lecturer survey on quality teaching in science. ............................................................................................................... 114
Figure 18. The relative frequency of combined Important responses to statements on the lecturer survey on quality teaching in science............................................. 116
Figure 19. The relative frequencies with which lecturers implemented the
categories they associated with quality teaching in science. .............................. 118

Figure 20. The relative frequencies of grouped differences between frequency of
implementation and importance to statements on the lecturer survey on quality
teaching in science. .................................................................................................. 120

Figure 21. Means and 95% confidence intervals for Factor 2 (culture and context) for
universities .................................................................................................................. 123

Figure 22. Means and 95% confidence intervals for Factor 2 (culture and context) for
grouped disciplines .................................................................................................... 124

Figure 23. The relative frequency of combined responses from Phase 1 and Phase 2 to
the lecturer survey on quality teaching in science .................................................... 168

Figure 24. A transformative framework for understanding quality teaching and learning
in undergraduate science .......................................................................................... 184

Figure 25. Model of a lecturer combining self-reflection and feedback from students
and lecturers to enhance reflective practice ............................................................. 188

Figure 26. Interactions resulting in lecturers changing their teaching .............................. 192

Figure 27. Key dimensions of the ecological model of teacher agency ......................... 197

Figure 28. A conceptual framework for the emergence of quality teaching and learning
in undergraduate science showing interrelated factors .............................................. 200

Figure 29. Box and whisper plot showing distribution of responses to the relative
importance of characteristics associated with quality teaching ............................... 259

Figure 30. Box and whisper plot showing distribution of responses to the frequency of
implementation of characteristics associated with quality teaching .......................... 260

Figure 31. Means and 95% confidence intervals for Factors 1, 2 and 3 for grouped
disciplines ................................................................................................................. 261

Figure 32. Means and 95% confidence intervals for Factors 1, 2 and 3 for universities A,
B and C ....................................................................................................................... 262

Figure 33. The relative frequency of uncombined relative importance responses from
Phase 1 and Phase 2 to the lecturer survey on quality teaching in science ................ 268
LIST OF TABLES

Table 1. Personal changes described in the transformative learning literature.......... 35
Table 2. Sensitising lenses for conditions to promote self-organisation based on complexity thinking and wickedity.................................................................................................................. 56
Table 3. The procedures planned for Phase 1: the exploratory sequential design Delphi study. .................................................................................................................................................. 67
Table 4. The procedures planned for Phase 2: the explanatory sequential design lecturer survey and interviews. .......................................................................................................................... 70
Table 5. The types of mixed methods legitimation (Onwuegbuzie & Johnson, 2006) and how they were addressed in this study.................................................................................................................. 73
Table 6. Relationships between research questions, methods and sensitising lenses. 78
Table 7. Delphi study Round 2 statements and strength of panel members’ responses to ‘Students learn science by . . . ’ .................................................................................................................................................. 92
Table 8. Delphi study Round 2 statements and strength of panel members’ responses to ‘Quality teaching in science at university means . . . ’ ........................................................................................................... 94
Table 9. Delphi study Round 2 statements and strength of panel members’ responses to views on preparation for working in science........................................................................................................... 96
Table 10. A provisional conceptual framework for understanding quality teaching and learning in science.................................................................................................................................................. 102
Table 11. Summary of exploratory factor analysis results for the lecturer survey questions on quality teaching .................................................................................................................................................. 122
Table 12. One-way ANOVA for Factor 2 between the Universities A, B and C........ 123
Table 13. Between-university comparisons for Factor 2: post-hoc tests (Tukey) for the one-way ANOVA. .................................................................................................................................................. 124
Table 14. One-way ANOVA for Factor 2 between the grouped disciplines. .......... 125
Table 15. Between discipline comparisons for Factor 2: post-hoc tests (Tukey) for the one-way ANOVA. .................................................................................................................................................. 125
Table 16. Interviewee demographics........................................................................ 139
Table 17. The categories, themes and subthemes identified with the problem definition lens as contributing to the problem of defining quality teaching and learning in undergraduate science.................................................................................................................................................. 146
Table 18. Quality as openness: the categories, themes and subthemes related to interacting or encountering new information or experiences identified with the openness lens. ................................................................. 152
Table 19. Quality as relationship: the categories related to social interactions identified with the social complexity lens. ................................................................. 156
Table 20. Quality as change: the categories and themes related to agents changing through local interactions identified with the nonlinearity lens. ......................... 158
Table 21. The influences that lecturers viewed as supporting their teaching........ 160
Table 22. The influences that lecturers viewed as negatively affecting their teaching. ................................................................................................................. 163
Table 23. Categories of survey statements based on combined findings from the lecturer survey and Delphi panel ................................................................. 169