UNIVERSITY OF SOUTHERN QUEENSLAND

Faculty of Engineering and Surveying

Problem Based Learning for teams working in virtual space

A Dissertation Submitted by

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Abstract

Australia is facing a critical shortage of engineers at all levels of the profession – associates, technologists and professional engineers. Universities face three main challenges in responding to this predicted shortfall: the impact of technology and the information revolution both on higher education and the profession, the increasing diversity and choices of the student population, and the changing requirements of governments, professional accreditation agencies, industry and society.

Over the last decade, universities have implemented recommendations from accrediting agencies to demonstrate the competencies of graduates in a broad range of key graduate attributes such as teamwork, communication and problem solving, as well as lifelong and self-directed learning. Universities have also strived to open the access pathways to higher education, granting entrance to more students with a wider range of educational backgrounds and ages and who are looking for flexible study patterns, that is, something other than full time on-campus. This trend is likely to continue in the future. Whilst the efforts of universities have resulted in changes to curricula and teaching methodologies, technology and the global economy is beginning to demand, if not new skills, then extensions of the current graduate attributes: working in a multicultural environment; working in interdisciplinary, multi–skilled teams; sharing of work tasks on a global and around–the–clock basis; working with digital communication tools and working in a virtual environment. These attributes are difficult to attain through traditional, didactic educational programs.

The intent of this dissertation is to document the design, implementation and evaluation of an innovative curriculum strategy to respond to these demands. Problem Based Learning (PBL) meets the demands of the profession with respect to technical content and key graduate attributes. The addition of virtual teams[1], students working in a team in virtual space with no face–to–face contact, is original and meets future demands of the profession and changes in the higher education sector. The research spans several broad areas including student teams working in

[1] Virtual team is a term used in the literature to describe a team working in virtual space, communicating via electronic communication technologies. A full definition is given on page 36.

distance education, engineering education, assessment, staff professional development and problem based learning. It takes an overarching view and develops, through an action research methodology, a model of how to deliver PBL to students studying by distance education and in particular for delivery to a large and diverse student cohort.

The research process identified five key areas for successful delivery of course content, both technical knowledge and graduate attributes, to meet student learning outcomes and requirements. These areas include: staff training and changing staff attitudes, curriculum development beginning with basics of team development, individual learning goals, communication skills, development of a 'learning community' among the students and staff, reflection and reflective practice and effective assessment in line with course objectives.

The dissertation presents a case study of successful design and implementation. Evaluation and confirmation of the strategy has been evidenced by a significant contribution to the current body of knowledge through peer reviewed publications, national awards and the uptake of the concepts and resources by other institutions and academics.

The research findings reported in this dissertation has demonstrated that PBL is successful in delivering key graduate attributes to students working entirely in virtual space. This has application in responding to the demands for flexible education initiatives and the global engineering workplace.

Certification of Dissertation

I certify that the ideas, experimental work, results, analyses and conclusions reported in this dissertation are entirely my own effort, except where otherwise acknowledged. I also certify that the work is original and has not been previously submitted for any other award, except where otherwise acknowledged.

_____ _____

Signature of Candidate Date

Endorsement

_____ _____

Signature of Principal Supervisor Date

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Lastly, thanks must go to my family, Ian, Ellen and Megan for always being there and always giving me the encouragement I needed.

Table of Contents

Abstract ..... *i*

Certification of Dissertation ..... *iii*

Acknowledgements ..... *v*

List of Figures ..... *x*

List of Tables ..... *xii*

Summary of Innovations and Original Contributions ..... *xiv*

Recognition of Innovation ..... **xvi**

1 Introduction *1*

1.1 Organisation of Dissertation **10**

1.2 List of Papers **11**

1.2.1 Publications directly related to the Award of Engineering Doctorate (EngD) 11

1.2.2 Supporting Publications 17

2 Literature Overview *19*

2.1 Problem Based Learning (PBL), Engineering Education & Distance Education **19**

2.1.1 History of Problem Based Learning (PBL) 19

2.1.2 Theory of Problem Based Learning 22

2.1.3 Problem Based Learning in Engineering Education 26

2.1.4 Distance Education and eLearning 31

2.2 Nexus between Engineering Education, Teamwork and Virtual Teams **35**

2.2.1 Virtual Teams – teams in virtual space 37

2.2.2 Virtual Teams in Education 39

2.2.3 Making Virtual Teams Work in a Learning Environment 42

2.3 Assessment – Teams & Problem Based Learning **46**

2.3.1 Assessment of Teamwork 47

2.3.2 Assessment in Problem Based Learning 49

2.4 Learning Community – Community of Practice **50**

2.5 Staff Training **51**

2.5.1 From Supervisory Role to Facilitator Role 52

3 Education Requirement and Context *56*

3.1 Introduction **56**

3.2 Student Demographics and Diversity **56**

3.3 Information Revolution **58**

3.4 Student, Government and Industry Requirements **59**

3.5 USQ Context and Responses **62**

3.6 The Case for PBL **65**

3.7 Summary **67**

4 Methodology 68

4.1 Introduction 68

4.2 The Research Process – a learning journey 69

4.3 Research Methods 77

4.3.1 Surveys 79

4.3.2 Interviews 79

Staff 80

Students 80

4.3.3 Use of Learning Management System 81

4.3.4 Thematic Analysis of Student Portfolios 82

4.4 Summary 83

5 Challenging the Boundaries – The Application of PBL to Distance and Online Education 84

5.1 Introduction 84

5.2 PBL in a Virtual Teams for Distance Education 86

5.3 Phase 1– An Initial Investigation of the First Offers 92

5.3.1 Student Profile and Perceptions 93

5.3.2 Student Issues 101

5.3.3 Staff (Facilitator) Perceptions 102

5.3.4 Summary of Initial Investigations 107

5.4 Changes to the Course 108

5.4.1 Foundations for a Successful Team 108

5.4.2 Reflective Writing – Helping Students Understand Their Learning 111

5.5 Phase 2 – Effectiveness of Change 112

5.5.1 Teamwork 117

5.5.2 Independent and Self Directed Learning 121

5.5.3 Communication Skills 126

5.5.4 Problem Solving Skills 128

5.6 Summary 131

6 Forming and Supporting Virtual Teams in Higher Education Using a Learning Management System 133

6.1 Introduction 133

6.2 PBL and Distance Education – a framework 134

6.3 Data from the LMS 137

6.4 Overview of Postings to Discussion Forums 141

6.4.1 Forming, Storming and Norming 142

6.4.2 Barriers to Participation and Learning 144

6.5 Summary 148

7 Assessment 149

7.1 Introduction 149

7.2 Overview of Assessment 150

7.3 Operational Aspects 155
7.3.1 Team Project Reports 156
7.3.2 Individual Portfolios 157
7.4 Analysis of Assessment Scheme 159
7.5 Assessment Rubrics 162
7.5.1 Background 163
7.5.2 Development of Rubrics 166
7.5.3 Evaluation of Rubrics 169
7.5.4 Results of Evaluation 170
7.6 Summary 176
8 Developing a Learning Community 178
8.1 Introduction 178
8.2 A Learning Community in Virtual Space 180
8.2.1 Social Learning 181
8.2.2 Facilitation Role 183
8.3 Developing a Common Goal 184
8.4 Recognising and Using Diversity 187
8.5 Developing Trust in the Team 191
8.6 Summary 192
9 Staff Training and Professional Development 194
9.1 Introduction 194
9.2 Instruction to Facilitation 194
9.3 Achievements 197
9.4 Summary 200
10 Conclusion and Further Work 202
10.1 Areas for further investigation 202
10.2 Conclusions 204
References 209
Appendix A 226

List of Figures

Figure 1-1 Scaffolding and articulation of the PBL courses in the Problem Solving Strand 6
Figure 1-2 Concept map of major interactions and overlaps in distinct research areas 9
Figure 2-1 Mechanisms for entry to undergraduate programs in Australia 33
Figure 2-2 Articulation of Faculty programs 34
Figure 2-3 Team phases and team outputs 43
Figure 3-1 Commencing student age profiles at USQ in the engineering programs . 63
Figure 4-1 Educational experience resulting in change 69
Figure 4-2 Research experience 71
Figure 4-3 Research contributing to the body of knowledge – a personal synthesis . 72
Figure 4-4 Areas and interactions of investigation 73
Figure 4-5 Action Research Strategy 78
Figure 5-1 Implementation and initial investigation 84
Figure 5-2 Scaffolding in the problem solving strand 88
Figure 5-3 Program distribution for the first offers 93
Figure 5-4 Students enrolled in each major 94
Figure 5-5 Experience in the work force 94
Figure 5-6 Student response on preference of lectures for course delivery 95
Figure 5-7 Student response to retention of knowledge being *less* than in traditional subjects. 96
Figure 5-8 Student response to the courses increasing learning ability 96
Figure 5-9 Student responses to the courses increasing their ability to undertake independent learning 97
Figure 5-10 Student response to PBL course enhancing their problem solving skills 97
Figure 5-11 Student response to PBL course increasing their appreciation of prior knowledge in problem solving. 98
Figure 5-12 Individual facilitator marks for portfolio (semester 1 2002) 105
Figure 5-13 Personal research process 107
Figure 5-14 Overview of team report 1 109
Figure 5-15 Program of enrolments 114

Figure 5-16 Distribution of discipline majors 114
Figure 5-17 Age profile of students 115
Figure 5-18 Student perceptions on the use of developing a team code of conduct 116
Figure 5-19 Student perceptions on teamwork 118
Figure 5-20 Setting my own goals was helpful to my learning 122
Figure 5-21 Survey responses to test student perceptions of independent and self learning skills 124
Figure 5-22 Retention of knowledge was less than in traditional courses 124
Figure 5-23 Student perceptions on the improvement of communication skills as a result of the course 128
Figure 5-24 Student perceptions on problem solving skills 129
Figure 5-25 Problem Solving cycle 131
Figure 6-1 A model for online teaching and learning 136
Figure 6-2 Usage of the LMS for a typical semester 138
Figure 6-3 Use of discussion forums 139
Figure 6-4 Average number of postings to discussion boards for a typical semester 139
Figure 6-5 Average number of postings per student per week 140
Figure 6-6 Total average time per student per week for semester 1 2007 140
Figure 6-7 Barriers to student learning in virtual teams 144
Figure 7-1 Task 1 of the first individual portfolio 156
Figure 7-2 Section of new marking rubric 168
Figure 7-3 Summary of final marks for each team 172
Figure 7-4 Student survey results relating to assessment over a three year period of development 174
Figure 8-1 Student self perceptions of the social aspect of the course – the course helped me to meet other students 182
Figure 8-2 Our team discussed and agreed on goal/s 186
Figure 8-3 Having a goal kept our team focused 186
Figure 8-4 Having a team goal help me participate in the team more effectively ... 186
Figure 8-5 Student responses to ‘my appreciation of how the prior knowledge and skills of my colleagues can be used to solve a problem has been increased’ 187
Figure 8-6 Student responses to ‘I used the skills and prior knowledge of my team members to help my learning’ 188

Figure 8-7 Student usage of the LMS – total average time per student for each week of semester for two typical semesters 190
Figure 8-8 Average mark for reflective portfolio by facilitators 198

List of Tables

Table 1-1 Comparison of graduate attributes from Engineers Australia and ABET ... 2
Table 1-2 Examples of literature discussing PBL in a virtual environment 7
Table 2-1 Requirements for engineers of the 21st century 27
Table 2-2 Modes and Functions to describe group activity 45
Table 3-2 Undergraduate programs in Engineering and Surveying..... 63
Table 4-1 Publications showing the work of author and contributions to BOK..... 74
Table 4-2 Supporting publications 76
Table 5-1 PBL Strand of Courses and team sizes 87
Table 5-2 Sample Problem outlines and learning objectives 92
Table 5-3 Themes from portfolios and surveys 99
Table 5-4 Student unsolicited reflections on main objects of the course..... 100
Table 5-5 Assessment criteria for Team Report 2..... 110
Table 5-6 Significant difference in student responses between on-campus and distance students..... 113
Table 5-7 Data for on-campus and distance students relating to problem solving and teamwork skills 114
Table 5-8 Correlation statistics 119
Table 5-9 Short answer response to the course evaluation survey – Teamwork 120
Table 5-10 Example of student entry for Portfolio 1 121
Table 5-11 Correlation statistics for problem solving skills and application of prior knowledge 130
Table 7-1 Comparison of marks and level of achievement for criterion of 'experimental methodology' 171
Table 7-2 Data for Student evaluations relating to assessment (2005 - 2007)..... 173

Summary of Innovations and Original Contributions

The principal innovation in this work is the integration of four separate areas within the Scholarship of Teaching and Learning, areas which have hitherto been essentially separate. These are Problem Based Learning, reflective practice in engineering education, distance education and virtual teams. The work presented in this dissertation advances some topics and then sets out a unification in the form of a single practical package. The unification also encompasses authentic assessment, community of practice, appropriate staff training and evaluation appropriate to the context. With this unification there have been contributions to the body of knowledge through peer reviewed publications and an uptake of materials developed by the author through the course of this project.

In 2000, when the work underpinning the dissertation began, there were no publications relating to student teams using Problem Based Learning when the teams were constrained to working *entirely* in virtual space. For practical reasons these teams could use only asynchronous (on–line) communication methods (i.e. not the telephone) and had no opportunity to meet face–to–face. Development of the program and support material has continued, making use of and evaluating new technologies and approaches (e.g. wikis) as they have become readily available. Recognition of student requirements, backgrounds and varying personal access to technology remains critical.

This work has the potential to create truly global engineering graduates by linking students across the world working in virtual teams and sharing tasks on an around–the–clock basis: a requirement for engineering graduates which is just emerging in the engineering education literature.

Developing, supporting and assessing teamwork skills in students have traditionally been problematic, particularly in engineering education when the priority has always been on ‘technical content’. However with the increasing emphasis on graduate attributes in engineering education (for example teamwork and communication), an increasingly diverse student cohort and the uptake of technology to deliver learning outcomes, teamwork and more importantly student learning about and through teams has taken on new dimensions. A major outcome of this dissertation is the proposal

of a model, illustrated in Figure I and discussed in detail in Chapter 6, which describes the interactions and barriers to student learning when confronted with the mix of teamwork and technology. Whilst this model was developed and tested for teams working in virtual space, it applies equally well to traditional on–campus teams and provides a structure for curriculum development for team and collaborative learning projects to maximise student learning and minimise the pitfalls and frustrations encountered by academics and students alike.

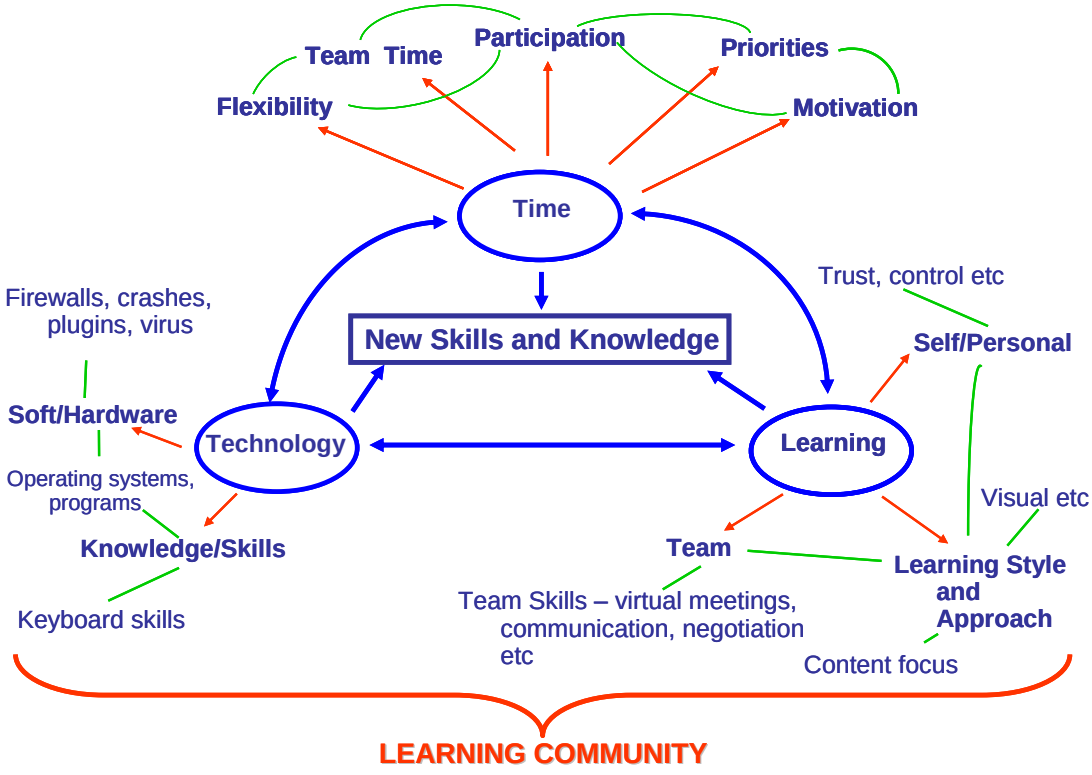

Figure I Barriers to student participation in teams

It is vital to effectively incorporate key graduate attributes into the engineering curriculum, a fact recognised by educators and industry alike. Outcomes of this work presents not only a development which supports curriculum change and effective delivery of both technical content and graduate attributes but looks to the future to ensure the education of engineers with skills to meet the challenges which lay ahead.

Recognition of Innovation

The work represented in this dissertation has been reviewed and its merit recognised by several external bodies in the form of university and national award as listed following. These awards are team awards as they recognise the *implementation* of the innovation and hence work of the teaching team. The major innovations and core development of the package are that of the author except where noted in the dissertation.

Awards

2008 Australasian Association for Engineering Education – Innovation in Curricula, Learning and Teaching "*Engineering Problem Based Learning Strand"* (Team Leader)

2007 Carrick Award for Australian University Teaching (now Australian Learning and Teaching Council ALTC) – Innovation in Curricula, Learning and Teaching "*Engineering Problem Based Learning Strand"* (Team Leader)

2006 Carrick Institute Citation (now ALTC) –"*Educating Engineers for the 21st Century – Successfully designing and delivering the world's first Problem–Based Learning course for distance engineering students*" (Team Leader)

2005 Finalist in Australian Awards for University Teaching (AAUT) Enhancement of the Quality of Teaching and Learning, Institutional Awards Category, "Educating Engineers and Surveyors for the 21st Century" (Team Leader)

2005 Australasian Association of Engineering Educators – Excellence in a Curriculum Team Project in Engineering Education (Team Leader)

2003 USQ Award for Excellence in Design and Delivery of Teaching Materials (Team Leader)

Use and Uptake of Materials

A number of course materials have been adopted by other courses.

Reflective Writing Guide:

- Used in CDS2002 Independent Project 1 from the Bachelor of Human Services program, Faculty of Business, USQ
- Used in Graduate Certificate in Tertiary Teaching and Learning, Faculty of Education, USQ
- Adapted for use in ENG8300 Self assessment portfolio from the Master of Engineering Practice program, Faculty of Engineering and Surveying, USQ
- Adapted for use in the OBL (Outcomes Based Learning) and Technology Enhanced Assessment Initiative at the Centre for Learning, Teaching and Technology (LTTC), The Hong Kong Institute of Education, Hong Kong

Peer and Self Assessment Resources:

- Used in ACC3101 Accounting Information Systems, Faculty of Business, USQ

All course materials have been reviewed and used, with acknowledgement, for the:

- 2008 ALTC Competitive Grant – "Business education in the 21st century: Examining the antecedents and consequences of student team virtuality (2008)"
- EDO3562 Teaching everyday science (Faculty of Education, University of Southern Queensland)