USING EFFECTIVE INFORMATION SEARCHING SKILLS TO SOLVE PROBLEMS

By

Muthukumar S Lakshmanan,
MA, BEng(Civil)(Hon), PGDE

Australian Centre for Educational Studies,
Macquarie University,
Sydney, Australia

2008

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy in Education
CONTENTS

Abstract ............................................................................................................................... x

Acknowledgement ............................................................................................................ xiii

CHAPTER 1 – INTRODUCTION .......................................................................................... 1

Background of the study ................................................................................................. 1

Statement of problem ...................................................................................................... 4

Research questions and hypotheses ............................................................................... 5

  Research questions (for qualitative analysis) .............................................................. 5

  Research hypotheses (for quantitative analysis) ......................................................... 6

Significance of study ...................................................................................................... 7

Limitations of study ....................................................................................................... 8

Organization of text in thesis ......................................................................................... 9

CHAPTER 2 – REVIEW OF THE LITERATURE .................................................................... 11

Problem solving ........................................................................................................... 13

Problem-based learning, its attributes and processes .................................................. 15

Design theory of problem solving ............................................................................... 19

  Structuredness ............................................................................................................ 20

  Typology of problems ............................................................................................... 23

  Individual skills differences ..................................................................................... 30

Information searching in problem solving .................................................................. 33

  Defining information literacy .................................................................................... 35

  Attributes of an information literate person ............................................................. 37

  The Internet – A vital informational and educational medium ......................... 39
CHAPTER 3 – METHODS AND PROCEDURES ........................................ 62

Purpose of the study ........................................................................ 62

Mixed methods design of the study and its rationale ................. 64

Research questions and hypotheses ........................................... 66

  Research questions .................................................................... 67

  Research hypotheses .................................................................. 67

Research site, its PBL methodology and sample ...................... 70

Sources of data ............................................................................ 74

Data collection procedures .......................................................... 75

  Phase 1 ......................................................................................... 77

  Phases 2, 3, 5, 6, 8 and 9 ........................................................... 77

  Phases 4 and 7 ............................................................................ 79

Assessment of student-authored artifacts .................................. 80

Data analysis procedures ............................................................... 82

  Analysis of quantitative data ....................................................... 82

  Analysis of qualitative data ......................................................... 88

Trustworthiness of study ............................................................... 91

CHAPTER 4 – PRE-INTERVENTION QUALITATIVE DATA ANALYSIS & DISCUSSION OF FINDINGS ................................. 92

Pre-intervention survey ................................................................. 92

Pre-intervention reflection journal .............................................. 104

  The Internet as a learning enabler ............................................. 106
The Internet as an information repository................................. 106
The shortcomings of the Internet ............................................. 107
General lack of awareness of information search strategies......... 108
Misconceptions of students..................................................... 110
Use of search engines and directories..................................... 111
Use of information search techniques.................................... 112
Pre-intervention phase problem 1 (Well-structured)................... 113
Results .................................................................................. 114
Discussion ............................................................................. 115
Students’ reflection journal inputs .......................................... 118
Life skills and analytical skills................................................. 118
Collaborative synergy ............................................................. 119
The Internet as the source of information................................. 120
Learning problems encountered ............................................. 120
Pre-intervention phase problem 2 (Ill-structured) ....................... 122
Results .................................................................................. 125
Discussion ............................................................................. 129
Students' reflection journal inputs ........................................... 138
Collaborative learning ............................................................ 139
Configurations of information space of problem ....................... 140
Lack of information planning ............................................... 142
CHAPTER 5 – INTERVENTION ................................................................. 144

Skill 1 (Phase 1) - Learning about Internet search tools .................................. 146

Skill 2 (Phase 2) - Using information search strategies

and techniques .............................................................................. 148

Skill 3 (Phase 3) - Framing essential and foundation research

questions ......................................................................................... 153

Results ............................................................................................... 164

Discussion .......................................................................................... 168

Skill 4 (Phase 4) - Developing and organizing search keywords ............... 172

Results ............................................................................................... 175

Discussion .......................................................................................... 177

CHAPTER 6 – POST-INTERVENTION QUALITATIVE DATA ANALYSIS &
DISCUSSIONS OF FINDINGS ............................................................. 180

Post-intervention phase problem 3 (Well-structured) ............................. 180

Results ............................................................................................... 182

Discussion .......................................................................................... 182

Students’ reflection journal inputs ..................................................... 185

Positive impact of intervention training ............................................. 186

Use of inverted commas ..................................................................... 187

Use of Boolean operators .................................................................. 188

Use of multiple search engines ......................................................... 189

Use of search strategies ..................................................................... 189

Students’ misconceptions ................................................................... 190
Post-intervention phase problem 4 (Ill-structured) .......................................................... 191
Results ................................................................................................................................. 196
Discussion ............................................................................................................................ 199
Students' reflection journal inputs .................................................................................... 206
Positive impact of intervention training ............................................................................ 207
Use of multiple search engines ......................................................................................... 207
Use of Boolean operators ................................................................................................... 209
Post-intervention phase problem 5 (Well-structured) ...................................................... 222
Results ................................................................................................................................. 214
Discussion ............................................................................................................................ 215
Students' reflection journal inputs .................................................................................... 221
Use of Boolean operators ................................................................................................... 224
Use of multiple search engines ......................................................................................... 225
Post-intervention phase problem 6 (Ill-structured) ........................................................ 226
Results ................................................................................................................................. 229
Discussion ............................................................................................................................ 233
Students' reflection journal inputs .................................................................................... 240
Positive influence of intervention training ........................................................................ 240
Use of techniques of questions crafting ............................................................................ 242
Use of Boolean operators ................................................................................................... 244
Use of multiple search tools ............................................................................................... 245
Impact of information searching skills on problem solving ............................................. 246
CHAPTER 7 – POST-INTERVENTION QUANTITATIVE DATA ANALYSIS & DISCUSSIONS OF FINDINGS .................................. 249

Findings for research hypotheses (1 and 2) ................................................................. 249

Discussion .................................................................................................................. 254

CHAPTER 8 – CONCLUSIONS .................................................................................... 258

Implications for teaching practice ............................................................................ 262

Further research ......................................................................................................... 265

APPENDIX A ............................................................................................................... 267

REFERENCES .............................................................................................................. 268
LIST OF TABLES

1. Attributes of an information literate person.................................37
2. Taxonomy of search strategies .................................................54
3. A path and its corresponding path matrix .................................83
4. Converted distance matrix for the path in Figure 6....................84
5. Values of status, contrastatus and prestige ..............................87
6. Team A's theme, topic and focus area ..................................175
7. Team B's theme, topic and focus area ..................................176
8. Team C's theme, topic and focus area ..................................176
9. Team D's theme, topic and focus area ..................................176
10. Team E's theme, topic and focus area ..................................176
LIST OF FIGURES

1. Schematic diagram of problem typology ............................................. 23
2. A network with compactness value of 0 ............................................. 58
3. A network with compactness value of 1 ............................................. 59
4. A network with a stratum value of 1 .................................................. 60
5. A network with a stratum value of 0 .................................................. 60
6. Schematic layout of data collection sequence .................................... 76
7. Path diagram ...................................................................................... 83
8. Team 1’s design solution ................................................................. 125
9. Team 2’s design solution ................................................................. 126
10. Team 3’s design solution .............................................................. 126
11. Team 3’s design solution .............................................................. 127
12. Team 4’s design solution .............................................................. 127
13. Team 4’s design solution .............................................................. 128
14. Team 5’s design solution .............................................................. 129
15. Training interventionist framework schema .................................. 145
16. Inspiration produced cluster diagram .......................................... 161
17. Amended Inspiration cluster diagram .......................................... 162
18. One example of keyword-category concept map ......................... 174
19. One example of keyword-category concept map constructed by
    students .......................................................................................... 178
20. Team 1’s concept map .................................................................... 229
21. Team 2’s concept map .................................................................... 230
22. Team 3’s concept map .................................................................... 231
23. Team 4’s concept map ................................................................. 232
24. Team 5’s concept map ................................................................. 232
25. Schematic representation of impact of information
   search skills on problem-solving .................................................. 248
26. Schematic representation of impact of information
   search skills on problem-solving .................................................. 248
27. Network with high stratum and low compactness values that
   represents the information navigation structure generated in
   solving well-structured problems .................................................. 252
28. Network with low stratum and high compactness values that
   represents the information navigation structure generated in
   solving ill-structured problems .................................................... 253
ABSTRACT

Problem-based learning (PBL) is an instructional approach that is organized around the investigation and resolution of problems. Problems are neither uniform nor similar. Jonassen (1998, 2000) in his design theory of problem solving has categorized problems into two broad types - well-structured and ill-structured. He has also described a host of mediating skills that impact problem solving outcomes. However, this list of skills is not exhaustive and in view of the utility of the Internet as an informational repository, this study examined the need for effective information searching skills to be included in this list.

This study was aimed at studying how students solve well and ill structured problems and how different Internet information seeking strategies can be used to engage in problem solving. This study devised and empirically tested the efficacy of an interventionist conceptual model that maps the application of different information seeking techniques to successfully resolving well and ill structured problem types. The intervention helps to better understand the influence of information searching skills on problem solving performance and the various problem solving strategies students can adopt in approaching problem solving. The contrasting patterns of navigational path movements taken by students in seeking information to resolve ill and well structured problems were also investigated.

A mixed methodology research design, involving a mix of quantitative and qualitative approaches was used in this study. The research site was a polytechnic in Singapore that has implemented problem-based learning in its
curriculum design. A first year class of 25 students were the sample population who participated in this study. Six problems from the curriculum were chosen for this study – three well-structured and another three ill-structured problems.

The research findings of this study inform that information searching skills indeed play an important role in problem solving. The findings affirm the need for students to be systematically instructed in the skills of information searching to be aware of the complexities involved in information seeking and accomplish desired problem solving goals. This study has also shown that well and ill structured problems demand different cognitive and information seeking capabilities. Well-structured problems are easily solved and come with singular correct answers. The information searching necessary for solving well-structured problems is constrained and readily manageable. Thus, students only have to be acquainted with fundamental information searching skills to solve well-structured problems. On the other hand, ill-structured problems are messy and contain a number of unknown elements. There are no easy prototypic solutions. Subsequently, the information needs of ill-structured problems are usually complex, multi-disciplinary and expansive. Hence, students have to be trained to apply a more advanced set of information searching skills in resolving ill-structured problems.
This thesis has not been submitted for a higher degree to any other university or institution. Approval from Ethics committee has been obtained in carrying out the research work of this thesis (HE25AUG2006-D04840).
ACKNOWLEDGEMENT

I would like to thank my supervisor, Professor John Hedberg of Macquarie University for his professional guidance, understanding and patience.

I am indebted to my wife, Galyna Kogut who has provided me with wonderful support throughout this arduous intellectual pursuit.

I would like to thank my parents who have always cultivated in me an appreciation for learning and knowledge seeking.

I would like to record my heartfelt gratitude to Brahmachari Gopal Chaitanya, Resident Acharya (Spiritual Teacher) of Chinmaya Mission Australia. Without his support in Sydney, this dissertation would not have materialized. His positive outlook to life was truly uplifting and inspirational.

This work of mine is dedicated to God – Lord Sri Krishna, in whom I trust and from whom I draw my strength.