

The relationship between cognitive load, cognitive style and multimedia learning

by

Anne Strehler

Submitted in partial fulfillment of the requirements for the degree

Philosophiae Doctor

in the

Department of Curriculum Studies

Faculty of Education

of the

University of Pretoria

Supervisor: Prof. Dr Johannes C. Cronjé

April 2008

Abbreviated Table of Contents

	Page
Summary	iii
Acknowledgements	iv
Table of Contents	v
List of Tables	x
List of Figures	xv
Abbreviations used in the study	xvii
List of Appendices	xviii
Chapter 1: Overview and Orientation	1
Chapter 2: Literature Review and Theoretical Framework	20
Chapter 3: Research Methodology and Design	123
Chapter 4: Presentation and Analysis of Empirical Data	172
Chapter 5: Discussion and Recommendations	278
References	330
Appendices	357

Summary

The purpose of this study was to investigate the relationship between cognitive load and cognitive style and explore the role cognitive load and cognitive style play in the achievement of learning outcomes, when using animation and static images as multimedia learning formats in an authentic learning environment. Two hundred and forty five 2nd year medical and dental students participated in the main study.

The majority of the participants had a Analytic style on the Wholistic-Analytic dimension and an Imager style on the Verbaliser-Imager dimension. It is not clear from the literature whether this is a typical cognitive style profile for health education learners. Cognitive load was measured using a subjective rating technique. The cognitive loads of the respective research interventions were significantly different, yet neither version appeared to have an excessive cognitive load that negatively influenced learning. Significant learning took place for all the participants in this study. Surprisingly it was found that when the program was considered as a whole the version that used predominantly animation had the lower cognitive load. When the analysis drilled down to specific screens and compared animation and static images and text the results consistently showed that animation had a higher cognitive load than static images and text.

This study established that there is empirical evidence that cognitive load influences learning performance. There are indicators that the Analytic cognitive style influences the subjective rating of cognitive load. Further empirical investigation of this relationship is necessary. The proposal is that the Analytic style influences the germane load experienced during learning. Since researchers are currently unable to measure the three different types of load separately this proposal remains an area for further investigation.

The subjective cognitive load rating of the program was compared with the cognitive load rating measured using the direct measurement method. The direct measurement method found that the animation version had the higher cognitive load. The correlation between these two methods of measurement was very low and not significant, thereby confirming a suggestion in recent literature that each method might be measuring different aspects of cognitive load.

Keywords: cognitive load, cognitive style, multimedia, animation, physiology education, learning, images

Acknowledgements

This study is dedicated to my husband - Dave

I would not have been able to undertake this work alone.

The three most important men in my life - Dave, Justin and Simon: Dave, for giving me the space to complete this study, for listening to my many ideas, smiling throughout the hard times and encouraging me during the low, for taking over the role of home exec. Justin and Simon, for their help at different times with literature searches and other 'boring' tasks, for being willing to turn the music down yet again.

My father: For all the proof reading you did.

Some special friends - Clif and Laurie, Todd and Heather: For the continued interest and support.

Johannes Cronje, my promoter and long-time e-Learning friend: For listening to my ideas and sharing my excitement about this study, for your support, advice and the most amazing turnaround times. Long live the sauna!

Elsabe Olivier: For introducing me to the world of electronic information sources and resources and for your continued interest in my progress over the past four years.

The Department of Physiology, University of Pretoria: For granting permission to conduct the study. To Dr N Willemse, for your help in spite of a full lecture programme and for the help with the content.

Prof Rheta Viljoen: For permission to re-use some of the animations from another multimedia, for looking at the content with your expert eye and for the interest in this study.

All the students who used the program: Without your co-operation this study would not have been possible. I wish you all success as you complete your own study programmes.

Stephan Visser and his team: For being there in a time of crisis and making Pilot Study No 2 possible.

Riekie Alberts: My research assistant - your help was invaluable.

My colleagues and friends at EPI-USE Learning: Thank you for your continued friendship and support. Death to split-attention!

Dr Mike van der Linde: For assistance with the statistical analysis, Department of Statistics, University of Pretoria.

Many other friends who cared: Carina Eksteen, Ina Treadwell, Irene le Roux, Dolf Jordaan, Rika Hefer, El-Marie Mostert, Estelle Drysdale.

Table of Contents

Abbreviated Table of Contents	ii
Summary	iii
Acknowledgements	iv
Table of Contents	v
List of Tables	x
List of Figures.....	xv
Abbreviations used in the study	xvii
List of Appendices	xviii
Chapter 1: Overview and Orientation	1
1.1 Introduction	1
1.2 Purpose of the study.....	1
1.3 Defining core concepts and terminology	2
1.3.1 Cognitive load	2
1.3.2 An introduction to style	4
1.3.3 Cognitive style.....	5
1.3.4 Learning style.....	5
1.3.5 Multimedia learning.....	5
1.4 Background to the study.....	6
1.5 Rationale of the research	8
1.5.1 The empirical imperative	8
1.5.2 The theoretical imperative	9
1.5.3 The methodological imperative	9
1.5.4 The media imperative	9
1.5.5 The contextual imperative	10
1.5.6 Other considerations	13
1.5.7 Pulling it together	13
1.6 Research questions.....	14
1.7 Research design and methodology	14
1.8 Analysis of the data	17
1.9 Limitations and strengths of the research.....	17
1.10 Organisation of the thesis.....	18
1.11 Summary.....	19
Chapter 2: Literature Review and Theoretical Framework.....	20
2.1 Introduction	20
2.2 Overview of Chapter 2.....	20
2.3 Literature sources	20
2.4 Introduction to the theoretical frameworks of this study	21
2.5 The cognitive theory of multimedia learning	23
2.6 Cognitive load theory.....	27
2.6.1 The human cognitive architecture	27
2.6.2 The construct 'cognitive load'	28
2.6.3 Practical application of cognitive load theory.....	31

2.7	Riding's cognitive style model	31
2.7.1	Wholist-Analytic Style	34
2.7.2	Verbal-Imagery Style	34
2.8	Summing up Part 1 of the Literature Review	35
2.9	Introduction to Part 2	36
2.10	Cognitive styles and multimedia learning	38
2.10.1	Contributions to the theory	39
2.10.2	Measurement of cognitive style.....	42
2.10.3	Cognitive style and learner characteristics	50
2.10.4	Cognitive style and behaviour	52
2.10.5	Cognitive style and instructional design practice.....	55
2.10.6	Cognitive style and achievement	56
2.10.7	In summary	59
2.11	Cognitive load and multimedia learning.....	61
2.11.1	Instructional design issues	62
2.11.2	Theory development and directions of research	72
2.11.3	Measurement of cognitive load	82
2.11.4	Learning from multiple representations	89
2.11.5	Animations, including animated pedagogical agents	97
2.11.6	In summary	105
2.12	Multimedia in health sciences education	107
2.12.1	The media effect	108
2.12.2	The multimedia effect	109
2.12.3	The Contiguity effect.....	112
2.12.4	Interaction effect	113
2.12.5	Perceptions and attitudes.....	113
2.12.6	Meta-analyses.....	115
2.12.7	Multimedia in Physiology Education	115
2.12.8	In summary	120
2.13	Conclusion following the literature view.....	120
	Chapter 3: Research Methodology and Design	123
3.1	Introduction	123
3.2	Overview of this chapter	123
3.3	Purpose of the study.....	124
3.4	The research questions	126
3.5	The research approach	127
3.6	The research design.....	128
3.6.1	The experimental design	129
3.6.2	Managing threats to validity.....	131
3.7	The research sample.....	133
3.8	The research data	134
3.8.1	Cognitive style data	135
3.8.2	Cognitive load data.....	135
3.8.3	Data for the presentation format	137
3.8.4	Learning performance data	137

3.9	The research instruments.....	137
3.9.1	Measuring cognitive style	139
3.9.2	Measuring cognitive load.....	139
3.9.3	Measuring learner performance	141
3.9.4	Integrating the research instruments into the intervention	142
3.10	Ethical considerations in this study	143
3.10.1	Obtaining consent to participate in the study.....	143
3.10.2	Informing participants about their cognitive style.....	144
3.10.3	Anonymity	144
3.10.4	Making all the formats available to the participants.....	145
3.11	Summary for Part 1	145
3.12	Introduction	146
3.13	Source of the content	146
3.14	Design and development of the multimedia	147
3.14.1	Design of the program	147
3.15	Instructional strategies and media used	149
3.16	The hypotheses and expected findings	152
3.16.1	Distribution of the styles across the sample	152
3.16.2	Cognitive load of the presentation formats	154
3.16.3	Rating of cognitive load according to style	156
3.16.4	The relationship between cognitive style, cognitive load and learning.....	157
3.17	Introduction	158
3.18	Conducting the pilot study.....	159
3.18.1	Pilot study 1.....	160
3.18.2	Pilot study 2.....	163
3.19	Conducting the main study.....	167
3.20	Summary.....	170
	Chapter 4: Presentation and Analysis of Empirical Data	172
4.1	Introduction	172
4.2	Statistical analysis	173
4.3	The profile of the participants	174
4.3.1	Age, gender and cultural group.....	175
4.3.2	Home language of the sample	177
4.3.3	Prior knowledge of the participants	178
4.3.4	In summary: profile of the participants	180
4.4	Time spent on each version of the intervention.....	180
4.4.1	Time spent on full program.....	180
4.4.2	Time spent on individual screens.....	183
4.4.3	In summary: time spent on the program	186
4.5	Exploring the role cognitive style plays in an authentic multimedia learning environment	186
4.5.1	Cognitive style as measured using Riding's CSA	187
4.5.2	Cognitive style and time spent on the program	194
4.5.3	Cognitive style and use of the multimedia program	203
4.6	Exploring the role cognitive load plays in an authentic multimedia learning environment.....	206
4.6.1	Self-report of cognitive load.....	207

4.6.2	The relationship between cognitive load and cognitive style	224
4.6.3	Subjective rating of cognitive load and other variables	239
4.6.4	Cognitive load and time spent on the program.....	241
4.7	The correlation between self-report of cognitive load and the direct measure of cognitive load	247
4.7.1	Comparing correlation of the measurement techniques by version	247
4.7.2	Comparing correlation of the measurement techniques without considering version.....	249
4.7.3	In summary	249
4.8	The interaction between cognitive style, cognitive load and learning performance in an authentic multimedia learning environment	250
4.8.1	Results of the pre- and posttest, independent of cognitive style and cognitive load..	250
4.8.2	Cognitive style and learning performance	266
4.8.3	The subjective rating of cognitive load and learning performance	268
4.8.4	Cognitive style, cognitive load and learning performance.....	269
4.9	Summary of Chapter 4	277
Chapter 5: Discussion and Recommendations		278
5.1	Introduction	278
5.2	Summary of the research	278
5.2.1	Purpose of the study.....	278
5.2.2	Background to the study.....	279
5.2.3	The literature review	279
5.2.4	Finding the research question.....	280
5.2.5	The rationale of the study	280
5.2.6	The research methodology.....	281
5.2.7	Conducting the study	284
5.2.8	Analysis of the results.....	285
5.3	Methodological reflection.....	286
5.3.1	The research approach and design	286
5.3.2	The research sample	289
5.3.3	The research instruments and data	290
5.3.4	The research intervention.....	291
5.4	Substantive reflection	292
5.4.1	The role of cognitive style in an authentic multimedia learning environment	292
5.4.2	The role of cognitive load in an authentic multimedia learning environment.....	300
5.4.3	The correlation between self-report and direct measurement as techniques in measuring cognitive load.....	306
5.4.4	Presentation formats and their influence on cognitive load	308
5.4.5	Cognitive load, cognitive style and learning performance.....	316
5.5	Scientific reflection.....	322
5.5.1	Contribution of this study to the body of knowledge.....	322
5.5.2	Implications of this study for instructional design	324
5.5.3	Implications of this study for using multimedia in the learning environment.....	325
5.5.4	Recommendations for future research	325
5.6	Conclusion	328
References		330

Appendix A: Summary of COGNITIVE Styles research reviewed by Riding and Cheema (1991) ...	357
Appendix B: Letter requesting permission to conduct the study and letter providing this consent ...	358
Appendix C: permission from Smith (2007) to use data from her study	360
Appendix D: Pre test / Posttest: Computer-based test	361
Appendix E: Final two questions of the Post test.....	367
Appendix F: Title screen and practice session screen	369
Appendix G: Multimedia intervention: Screens common to both formats	371
Appendix H: Multimedia intervention: Different strategies to display SAME content.....	382
Appendix I: multimedia: Animation versus static images.....	384
Appendix J: Multimedia intervention: Whole view versus Parts view.....	389
Appendix K: A summary of the Multimedia and the integration of the research instruments.....	392
Appendix L: Electronic questionnaire to collect demographic data.....	394
Appendix M: Allocation of groups for the main study.....	395
Appendix N: Example of data for a single participant - written out to an .INI file	396
Appendix O: Student handout - Participation in the study	407
Appendix P: Riding's Cognitive styles Analysis	412

List of Tables

		Page
Chapter 1	Overview and Orientation	
Table 1.1	Cognitive load - types and sources of load	3
Table 1.2	Contexts of cognitive load research	11
Table 1.3	Contexts of cognitive style research, using Riding's CSA and other measures of cognitive style	12
Table 1.4	Summary of the research instruments and nature of the data	16
Table 1.5	Summary of the methods used to analyse the data	17
Chapter 2	Literature Review and Theoretical Framework	
Table 2.1	Detailed outline of the parts of Chapter 2	20
Table 2.2	List of special edition education journals devoted to cognitive load and/or multimedia research	21
Table 2.3	Approach to the literature review	38
Table 2.4	Assumptions underlying different techniques for measuring cognitive load	83
Table 2.5	The media effect in health sciences multimedia education	108
Table 2.6	The multimedia effect in health sciences multimedia education	110
Table 2.7	The contiguity effect in health sciences multimedia education	112
Table 2.8	The interaction effect in health sciences multimedia education	113
Table 2.9	Perceptions of and attitudes towards multimedia education in the health sciences	113
Table 2.10	Meta-analyses of research into multimedia education in the health sciences	115
Table 2.11	Review of recent research in Physiology education	115
Table 2.12	The literature review and the research questions	122
Chapter 3	Research Methodology and Design	
Table 3.1	Detailed outline of Chapter 3	124
Table 3.2	Managing threats to validity	131
Table 3.3	Operational definitions of the variables	135
Table 3.4	Summary of research instruments used in this study	138
Table 3.5	Number of times cognitive load was measured in each version	143
Table 3.6	A summary of the major design similarities and differences between the programs	148
Table 3.7	Scope of the content of the multimedia program	150
Table 3.8	Profile of the research sample	159
Table 3.9	Placement of the secondary task across four programs	165

	Page
Chapter 4 Presentation and Analysis of Empirical Data	
Table 4.1 Distribution of sample across research intervention, by age and gender	176
Table 4.2 Number of participants who had studied topic previously	178
Table 4.3 Time groupings for each version of the program	181
Table 4.4 Mean time spent on program for each version	182
Table 4.5 Frequency of access for screen 12 in the animation version and screen 13-16 in the static images & text version	185
Table 4.6 Profile of the sample for the WA dimension of the CSA using three style groups	188
Table 4.7 WA style ratios according to gender	189
Table 4.8 WA style ratios according to culture	189
Table 4.9 Stepwise regression equation for WA style	190
Table 4.10 Profile of the sample for the Verbaliser-Imager Dimension of the CSA using three style groups	191
Table 4.11 VI style ratios according to gender	192
Table 4.12 VI style ratios according to culture	193
Table 4.13 Stepwise regression equation for VI style	193
Table 4.14 Frequency of WA and VI styles for each version of the program	195
Table 4.15 Comparison of time spent on program for WA style and version	195
Table 4.16 Comparison of time spent on selected screens for WA style	196
Table 4.17 Comparison of time spent on the animation version for the WA style dimension	197
Table 4.18 Comparison of time spent on the static images & text version for the WA style dimension	198
Table 4.19 Comparison of time spent on program for VI style and version	199
Table 4.20 Comparison of time spent on selected screens for VI style	200
Table 4.21 Comparison of time spent on the animation version for the VI style dimension	201
Table 4.22 Comparison of time spent on the static images & text version for the VI style dimension	201
Table 4.23 Cognitive style of participants who accessed the program once only	204
Table 4.24 Results of Chi-square analyses to determine relationship between style and access in the animation version	205
Table 4.25 Results of Chi-square analyses to determine relationship between style and access in the static images & text version	206
Table 4.26 Overview of content for the animation version on which self-report of cognitive load was based	207
Table 4.27 Frequencies of cognitive load reported as low, medium and high for the animation version	208

	Page	
Table 4.28	Mean cognitive load ratings for individual measurements of cognitive load in the animated version	209
Table 4.29	A comparison of the cognitive load for selected screen pairs in the animation version	210
Table 4.30	Effect sizes for comparisons between screen in the animation version	211
Table 4.31	Overview of content in the static image & text version on which self-report of cognitive load was based	212
Table 4.32	Frequencies of cognitive load reported as low, medium and high for the static images & text version	213
Table 4.33	Mean cognitive load ratings for individual measurements of cognitive load for the static images & text version	214
Table 4.34	A comparison of the cognitive load for selected screen pairs in the static text & images version	215
Table 4.35	Effect sizes for comparisons between screen in the static images & text version	216
Table 4.36	Cognitive load using direct measurement technique	217
Table 4.37	Results of GLM Repeated Measures Analysis for the cognitive load comparisons	217
Table 4.38	Effect sizes of comparison of mean cognitive load measured with the direct method	218
Table 4.39	Mean cognitive load per version using the subjective rating technique	220
Table 4.40	Screen-wise comparison of cognitive load for selected presentation formats	221
Table 4.41	Cognitive load of selected screens using the direct method of measurement	223
Table 4.42	Cognitive load for WA style dimension	225
Table 4.43	Cognitive load and the WA style dimension by version	225
Table 4.44	Cognitive load of the WA styles for each version	226
Table 4.45	Cognitive load levels and the WA style dimension	227
Table 4.46	Cognitive load for the Analytic learner grouped by time spent on program	228
Table 4.47	T-test for significance for the comparisons of cognitive load per time group for the Analytic learner	229
Table 4.48	Cognitive load and VI style	230
Table 4.49	Cognitive load and the VI style dimension by version	230
Table 4.50	Cognitive load of the VI styles for each version	231
Table 4.51	Cognitive load levels and the VI style dimension	232
Table 4.52	Cognitive load for the VI style grouped by time spent on the animation version	232
Table 4.53	T-test for significance for the comparisons of cognitive load per time group for the Verbaliser learner	234

	Page	
Table 4.54	Cognitive load for the VI style grouped by time spent on the static images & text version	235
Table 4.55	T-test for significance for the comparisons of cognitive load per time group for the Imager learner	236
Table 4.56	Stepwise regression equation for self-report rating of cognitive load	240
Table 4.57	GLM analysis results for cognitive load and rating of knowledge about the topic	241
Table 4.58	GLM analysis results for cognitive load and home language	241
Table 4.59	Cognitive load for time spent on program by version	242
Table 4.60	Cognitive of screen 12 where there were multiple entries to the screen	243
Table 4.61	Cognitive of screen 19 where there were multiple entries to the screen	243
Table 4.62	Cognitive load of screen 23 where there were multiple entries to the screen	244
Table 4.63	Cognitive load of screens 13, 14, 15 and 16 where there were multiple entries to each of these screens	245
Table 4.64	Mean cognitive load using direct measurement (Smith, 2007)	248
Table 4.65	Means for the cognitive load, using different measurement techniques	248
Table 4.66	Pretest questions and answers and the number of participants who answered correctly and incorrectly	253
Table 4.67	Learning performance and self-report of previous exposure to topic	255
Table 4.68	Learning performance and self-report of level of knowledge of topic	256
Table 4.69	Pretest results and self-rating of prior knowledge and understanding of topic	257
Table 4.70	Pretest by version	258
Table 4.71	Posttest questions and answers and the number of participants who answered correctly and incorrectly	261
Table 4.72	Posttest by version	263
Table 4.73	Mean score for Question 1 of the open-ended questions for each version of the program	264
Table 4.74	Mean score for Question 2 of the open-ended questions for each version of the program	264
Table 4.75	Mean scores for the pre- and posttests by version	266
Table 4.76	GLM analysis results for WA style and learning performance	267
Table 4.77	GLM analysis results for VI style and learning performance	267
Table 4.78	GLM analysis results for version and performance	268
Table 4.79	Posttest results for the Analytic learner, by time and load	271
Table 4.80	Posttest results for the animation version learner for the VI style by time and load	273
Table 4.81	Posttest results for the static images & text version learner for the VI style by time and load	275
Table 4.82	Stepwise regression equation for posttest results	276

		Page
Chapter 5	Discussion and Recommendations	
Table 5.1	Overview of Chapter 5	278
Table 5.2	A summary of the major design similarities and differences for the programs	284
Table 5.3	Profile of the research sample	285
Table 5.4	Reflecting on the research design	288
Table 5.5	Alignment of the instruments used in the study with criteria for good instruments	291

List of Figures

		Page
Chapter 2	Literature Review and Theoretical Framework	
Figure 2.1	A framework for a cognitive theory of multimedia learning (Mayer, 2003:129)	26
Figure 2.2	The construct cognitive load	28
Figure 2.3	Riding's Cognitive Style Model	33
Figure 2.4	Relationships between cognitive load, cognitive style and multimedia learning	37
Figure 2.5	New relationships between cognitive style, cognitive load and multimedia learning	37
Figure 2.6	Progression for the 'effects' research within the cognitive load research stream	63
Figure 2.7	Cognitive load research timeline	76
Figure 2.8	Assumptions of cognitive load (Gerjets & Scheiter, 2003, page 35)	78
Figure 2.9	Goals and strategies as moderators between instructional design and cognitive load (Gerjets & Scheiter, 2003, page 36)	79
Figure 2.10	Relationships of physiology with related Medical Science (Sefton, 1998, pg. 54)	115
Chapter 3	Research Methodology and Design	
Figure 3.1	A visual representation of the research methodology	123
Figure 3.2	Graphic representation of the issues that define this research design	129
Figure 3.3	Screen format of self-reporting a rating for mental effort	140
Figure 3.4	Menu for multimedia intervention used in the second pilot study	142
Figure 3.5	A visual representation of the structure of the multimedia program	148
Figure 3.6	Display of secondary task in the program used in pilot study 1	162
Figure 3.7	How remaining time was displayed on screen in the pretest	164
Figure 3.8	The message that was displayed in pre- and posttest once time had elapsed	164
Figure 3.9	Placement of the secondary task in Programs 1 and 3	165
Figure 3.10	Placement of the secondary task in Programs 2 and 4	165
Chapter 4	Presentation and Analysis of Empirical Data	
Figure 4.1	Gender profile of the sample	175
Figure 4.2	Profile of sample by gender and age	175
Figure 4.3	Profile of sample by cultural group	177
Figure 4.4	Percentage of participants where English is their home language	178

		Page
Figure 4.5	Rating of level of knowledge and understanding	179
Figure 4.6	Access to screen 16 in the static images & text version	184
Figure 4.7	Example of question in pretest	251
Figure 4.8	Distribution of pretest scores	251
Figure 4.9	Distribution of posttest scores	259
Figure 4.10	Distribution of pre- and posttest scores: Low, Average and High Performance	259
Figure 4.11	Comparison of pre- and posttest scores for each score in the range	265
Chapter 5	Discussion and Recommendations	
Figure 5.1	Screen 5 – First image	310
Figure 5.2	Screen 5 – Second and third image	311
Figure 5.3	Screen 5 – Fourth image	311
Figure 5.4	Section of screen 13 in Version 2	313
Figure 5.5	Section of screen 20 in Version 2	314
Figure 5.6	View from screen 18 in the static images & text version	315
Figure 5.7	Perspectives of the study	328

Abbreviations used in the study

ANS	Autonomic Nervous System
AV	Analytic–Verbaliser (unitary style)
AI	Analytic–Imager (complementary style)
CAI	Computer-Assisted Instruction
CAL	Computer-Assisted Learning
CBT	Computer-based instruction
CLT	Cognitive Load Theory
CSA	Cognitive Styles Analysis
CSI	Cognitive Styles Index
Exp	Experiment
Extended CSA-WA	Extended Cognitive Style Analysis–Wholistic–Analytic test
FD	Field-Dependence
FI	Field-Independence
GEFT	Group Embedded Figures Test of Witkin
GCSE	General Certificate of Secondary Education (UK)
IT	Information Technology
fMRI	Functional Magnetic Resonance Imaging
PBL	Problem-based learning
PNI	Psychoneuroimmunology
PNS	Parasympathetic Nervous System
SBLSQ	Santa Barbara Learning Style Questionnaire
SNS	Sympathetic Nervous System
SRCL	Self-report cognitive load
SRCLV	Total self-report cognitive load of the lesson for each participant
UP	University of Pretoria
Vers	Version
VI	Verbaliser-Imager (style dimension)
VICS	Verbal Imagery Cognitive Style
VVLSR	Verbal-Visual Learning Style Rating
WA	Wholistic-Analytic (style dimension)
WM	Working memory
WV	Wholistic–Verbaliser (complementary style)
WI	Wholistic–Imager (unitary style)
WA-IT	Wholistic-Analytic Inspection Time test

List of Appendices

		Page
Appendix A	Summary of Cognitive Styles research reviewed by Riding and Cheema (1991)	357
Appendix B	Letter requesting permission to conduct the study and letter providing this consent	358
Appendix C	Permission from Smith (2007) to use data from her study	360
Appendix D	Pre test / Posttest: Computer-based test	361
Appendix E	Final two questions of the Post test	367
Appendix F	Title screen and practice session screen	369
Appendix G	Multimedia intervention: Screens common to both formats	371
Appendix H	Multimedia intervention: Different strategies to display content	382
Appendix I	Multimedia intervention: Animation versus static images	384
Appendix J	Multimedia intervention: Whole view versus Parts view	389
Appendix K	A summary of the multimedia and the integration of the research instruments	392
Appendix L	Electronic questionnaire to collect demographic data	394
Appendix M	Allocation of groups for the main study	395
Appendix N	Example of data for a single participant - written out to an .INI file	396
Appendix O	Student handout - Participation in the study	407
Appendix P	Riding's Cognitive styles ANALYSIS	412