

Declaration

I declare that this dissertation does not incorporate, without acknowledgment, any material previously submitted for a Degree or a Diploma in any University and to the best of my knowledge and belief, it does not contain any material previously published or written by another person or myself except where due reference is made in the text. I also hereby give consent for my dissertation, if accepted, to be made available for photocopying and for interlibrary loans, and for the title and summary to be made available to outside organization.

P. D. Dayaratne

Name of Student

Signature of Student

Date



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Supervised by

Dr. Ajith P Madurapperuma

Name of Supervisor(s)

Signature of Supervisor(s)

Date

Acknowledgement

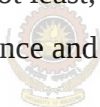
It is my greatest pleasure to pay my sincere gratitude towards all those who supported me in numerous ways to complete this project successfully.

First of all, I would like to thank my supervisor, Dr. Ajith Madurapperuma, Senior Lecturer of Faculty of Information Technology, University of Moratuwa, for his dedication, extended support, guidance and knowledge given to make the project a success.

I should thank the staff of IT faculty of University of Moratuwa, for the guidance and facilities provided.

Appreciation should go to the entire batch that helped in numerous ways.

Last but not least, I would like to thank my family, office colleagues and friends for the assistance and encouragement provided to make the project a success.



www.lib.mrt.ac.lk

Abstract

Learning and emotions have a strong correlation. A student in good emotional state that encourages learning helps to grasp new concepts and learn effectively, and vice versa.

In eLearning, emotions of a student are not addressed as it is addressed in traditional class room. As a stepping stone to develop an emotion adaptive learning system, this project focuses on identifying the parameters derived from learner's interactions with the system that affect emotions.

Student's interactions are captured while interacting with the e-Learning system. These interactions are converted into quantified parameters. These parameters are collected for all students under observation, and then analyzed which contribute to explain the performance of students. The theory behind this used is the fact that learning encouraging emotions contribute to productive learning and better performance.

The infrastructure to capture data is a web based system and it is used to administer the system as well as keep persistent data required for the analysis. Also it is used to report the results of analysis.

The student's desktop system will record interactions with the system once the student logs into the system and starts learning a subject, until logged out. An application installed in student's desktop will be run in the background to capture interaction information that will be converted to parameter values. These parameter values become the input for the analysis that is performed in the server.

Data analysis method used is Multiple Regression Analysis. Parameter values for each student are collected and recorded in the server and the analysis is performed.

The analysis will report the interested parties about the relevant parameters that affect emotions, at the requested significance level and will show how the analysis should be carried out again to arrive at a better result.

In conclusion, it can be stated that there exists a positive correlation between emotions and learning. Also it can be concluded that the framework developed is capable of obtaining values for parameters derived from keyboard, mouse and navigational patterns related interactions to test and identify emotions in an e-Learning environment. Also, after testing and evaluating the framework, the conclusion derived was that at 90% confidence level, none of the parameters used in the experiment can be used identify emotions.



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Contents

	Page
Chapter 1 – Introduction	01
1.1 Introduction	01
1.2 Aim and Objectives	02
1.3 Solution	03
1.4 Structure of the dissertation	04
 Chapter 2 – Human – Computer Interactions, emotions, e-Learning and their interconnections	 05
2.1 Introduction	05
2.2 Study on human emotions	06
2.3 Study on connection between emotions and learning	07
2.4 Study on analysis of emotions in computing and affective computing	07
2.5 How user interactions are used in human emotions capture in computing environment	07
2.6 Problems encountered in using the above methodologies in an e-Learning system	08
2.7 Knowledge representation and Analysis	08
2.8 Conclusion	09
 Chapter 3 – A Multiple Regression analysis for identifying relevant parameters that explains student’s emotions	 10
3.1 Introduction	10
3.2 Learning and Emotions, interconnection with dependent parameter	11
 Chapter 4 – Using Multiple Regression to identify parameters	 13
4.1 Introduction	13

4.2 Data captured	13
4.3 Define parameters	14
4.4 Scope	15
4.5 Users and their functions	15
4.6 Assumptions	16

Chapter 5 – Identifying User Interactions based parameters that affect emotions in e-Learning environment 17

5.1 Introduction	17
5.2 Model Equation	17
5.3 Parameters	18
5.3.1 Deviation from expected time spent on a content page - X_1	18
5.3.2 Deviation from expected time spent using application program groups defined for the subject X_2	18
5.3.3 Relevancy of Number of Applications used X_3	19
5.3.4 Time spent on Relevant Applications used X_4	20
5.3.5 Content feedback Index X_5	20
5.3.6 Emotions feedback index X_6	22
5.3.7 Deviation from total subject duration X_7	22
5.3.8 Keyword usage index X_8	23
5.3.9 Profile rating X_9	23
5.4 Results	23
5.5 Statistical Testing	
5.5.1 Overall Effectiveness of the Model	24
5.5.1.1 Multiple Coefficient of Determination R^2 & Adjusted Multiple Coefficient of Determination R_a^2	24
5.5.1.2 F – Statistic	25
5.5.2 Significance of the individual independent variables	25
5.5.3 Detecting Serial Correlation (Autocorrelation)	27

5.5.4	Testing for Heteroskedasticity	28
5.5.5	Detecting Multicollinearity	28
5.6	Conclusion	29
 Chapter 6 – Requirements analysis of the software systems to capture interactions data and provide e-Learning Mateiral		 31
6.1	Introduction	31
6.2	Scope	31
6.3	System environment	32
6.4	User Characteristics	32
6.5	System requirements definitions	32
6.5.1	Functional Requirements	33
6.5.2	Non-Functional Requirements	35
 Chapter 7 – Design and Implementation		 36
7.1	Introduction	36
7.2	Overview of Subsystems and Modules	37
7.2.1	Administration Sub System	40
7.2.1.1	Course Administration	40
7.2.1.2	Students Administration	40
7.2.1.3	Staff Member Administration	40
7.2.2	Content Providing Sub System	40
7.2.2.1	Content Categorization	41
7.2.2.2	Content Providing	41
7.2.3	Interactions Capturing Sub System	41
7.2.3.1	Mouse Interactions Capturing, Keystroke Capturing and application usage monitoring	41
7.2.3.2	Internet search monitoring	42
7.2.4	Data Analysis and Parameter Identifying Sub System	42
7.2.4.1	Interactions parsing	42
7.2.4.2	Parameter identifying	43
7.3	System Testing	43
7.4	Summary	43

Chapter 8 – Evaluation	44
8.1 Introduction	44
8.2 Evaluation of the framework	44
8.3 Experiment Methodology	44
8.3.1 Introduction	44
8.3.2 Experiment Environment Setup	45
8.3.3 Target sample details	45
8.3.3.1 Sample of Students	45
8.3.3.2 Sample Subject	45
8.3.4 Experiment execution	47
8.4 Data collection	48
8.4.1 X_1 : Deviation from expected time spent on a content page	48
8.4.2 X_2 : Deviation from expected time spent using application groups defined for the subject	51
8.4.3 X_3 : Relevancy of Applications used	52
8.4.4 X_4 : % Time spent on Relevant Applications used	52
8.4.5 X_5 : Content feedback Index	53
8.4.6 X_6 : Emotions feedback index	54
8.4.7 X_7 : Deviation from total subject duration	55
8.5 Data Analysis and Results	56
8.5.1 Overall effectiveness of X_i in explaining Y_i	59
8.5.2 Significance of the individual independent variables	60
8.6 Analysis conclusion	61
Chapter 9 –Conclusion & Further work	62
9.1 Conclusion	62
9.2 Achievement of objectives	62
9.2.1 Critical study about e-learning systems, emotions capturing in human computer interactions.	62
9.2.2 Design and develop the framework	62

9.2.3	Test and evaluate the approach	63
9.2.4	Prepare the final documentation.	63
9.3	Problems encountered	63
9.4	Limitations of the system	64
9.5	Further work	64
References		65



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Appendix

		Page
Appendix A	Extract of SRS - Analysis	68
Appendix B	Implementation- User Interfaces samples	76
Appendix C	Implementation: Code Listing Samples	79
Appendix D	Installation Guides	94
Appendix E	Sample Questions and Questionnaire	102
Appendix F	Sample of Data Collected	103
Appendix G	Documents used in conducting experiment	104



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

List of Figures

	Page
Figure 1.1 – Data Capturing, Analyzing and Reporting system	3
Figure 3.1 – Four Quadrant model relating to emotions.	11
Figure 4.1 – Functionality of the system – Analysis and testing perspective	15
Figure 4.2 – High level Usecase diagram	16
Figure 5.1 – Durbin – Watson statistic hypothesis	27
Figure 6.1 – Detailed Use case diagram	34
Figure 7.1 – Top Level Architectural Design Diagram	36
Figure 7.2 Class Associations	38
Figure 7.3 Classes with attributes	39



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

List of Tables

	Page
Table 5.1– Application group usage time	19
Table 5.2– Feedback rating setting for subject content page	21
Table 5.3– Example of feedback rating obtained by a student	21
Table 5.4– Example of feedback rating obtained by a student	22
Table 5.5– Regression Results	23
Table 5.6– ANOVA	24
Table 5.7– t-statistic table	24
Table 5.8– Significance of individual variables	26
Table 5.9– Multicolleniarity table	29
Table 7.1 – Interactions related details captured in the system	37
Table 8.1- Information required to find parameter values and expected parameter	46
Table 8.2- Excluded Parameters	47
Table 8.3- Actual time spent on a content page in seconds	49
Table 8.4- Deviation of time spent on a content page to – data for parameter X1	50
Table 8.5- Deviation from expected time spent using application programs defined for the subject	51
Table 8.6- Relevancy of Applications used	52
Table 8.7- % Time spent on Relevant Applications used	53
Table 8.8- Rating given for understanding content feedback	53
Table 8.9: Content feedback Index	54
Table 8.10: Ratings given for feedback on emotional states	54
Table 8.11: Emotions feedback index	55
Table 8.12: Deviation from total subject duration	56
Table 8.13: Parameter values for analysis	57
Table 8.14: Regression analysis results	58
Table 8.15: t-test results	60