

UNIVERSITY OF MINNESOTA

This is to certify that I have examined this copy of a doctoral dissertation by

Barry Robert Brahier

and have found that it is complete and satisfactory in all respects,  
and that any and all revisions required by the final  
examining committee have been made.

JOAN E. HUGHES

SIMON HOOPER

Names of Faculty Advisors

Joan E. Hughes

Simon Hooper

Signatures of Faculty Advisors

June 2, 2006

Date

GRADUATE SCHOOL

**Examining a Model of Teachers' Technology Adoption Decision Making:  
An Application of Diffusion of Innovations Theory**

**A DISSERTATION  
SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL  
OF THE UNIVERSITY OF MINNESOTA  
BY**

**Barry Robert Brahier**

**IN PARTIAL FULFILLMENT OF THE REQUIREMENTS  
FOR THE DEGREE OF  
DOCTOR OF PHILOSOPHY**

**Joan E. Hughes, Co-Advisor  
Simon E. Hooper, Co-Advisor**

**July, 2006**

© Barry Robert Brahier 2006

## Acknowledgments

This dissertation is the result of the contributions of a number of individuals.

First, I acknowledge the contributions of my lead advisor, Dr. Joan Hughes. Joan, you are a marvelous teacher. You knew how much I was capable of, exactly how much to push and when, and precisely how to support me in learning to become a researcher. If writing a dissertation is a path that rises upward, you lit the path ahead, held me to it, and guided me away from trouble and on to the summit. Second, I thank my co-advisor, Dr. Simon Hooper. Simon, your ability to play the devil's advocate made me think and deepen my arguments without making me doubt myself. From you I learned to think critically and confidently.

I thank my committee members for their contributions. Dr. Michael Harwell, thank you for teaching me about the strength available through casting results inside a small frame and for inspiring me through your willingness to be of service. Dr. Jean King, thank you for your incisive and detailed reading of the dissertation and for your compassionate quips during the final months. Dr. JoAnne Buggey, thank you for planting the seed at the start and for all your encouragement to finish at the end.

In addition to my committee, several other individuals contributed their time and expertise. Yukiko Maeda generously gave of her time to train me in logistic regression with clarity, rigor, and compassion. Dr. Paul Halvorson served as my coach throughout, keeping me motivated, on track, and attending to all arenas of my life. I am also deeply indebted to all the teachers who participated in the study and the school leaders who made it possible for me to work with such a dedicated group of teachers.

Finally, and most importantly, I acknowledge Janet Brahier, my wife of nearly 20 years. Janet, you were (and are) amazing. Your capacity to love and support me throughout this effort eclipses my understanding. Through you I have been loved with a love that knows no bounds. My gratitude is only exceeded by the number of bright, shining possibilities that lie before us!

*In memory of*

*my mother, Jeanne Topping Brahier, the first researcher I ever knew*

*and my father-in-law, Robert G. Wiche,*

*whose dignity and integrity inspire me always.*

*In honor of*

*the students it was my privilege to teach, for whom I do this work.*

## Abstract

This study developed and investigated a model of K-12 teachers' technology adoption decision-making using a diffusion of innovations theoretical framework. This study examined the ability of a 15-factor model to indicate teachers' decisions to participate in a field trial of a software innovation and to implement the innovation in their classrooms. Teachers (N=60) from a K-12 school district participated in an introductory workshop where they examined RepliGo™ digital annotation software (the innovation). Surveys and interviews were used to collect data on teacher characteristics (i.e., age, educational attainment, career moves, individual innovativeness, perceived organizational innovativeness) and teachers' perceptions of the innovation (i.e. relative advantage over other ways of assessing reading comprehension, compatibility with current and preferred work practices, compatibility with values, compatibility with prior experiences, ease of use, image enhancement, ease of communicating the results of using the innovation, impact of using the innovation, degree of experimentation permitted) immediately before and after teachers made their field trial participation decision. In addition, interviews were conducted with two teachers who engaged in the four-week field trial of the innovation in their classrooms. Logistic regression analysis was used to analyze the model. Qualitative analysis analyzed teachers' perceptions of the innovation and to what degree the innovation replaced, amplified, or transformed their instruction, curriculum, and student learning. Teachers' perceptions of the innovation's compatibility with current work practice and relative advantages were significant indicators of adoption and implementation of the innovation. Results indicated that teacher characteristics were not indicators of the field trial participation decision. The two teachers used digital

annotation during the field trial to amplify and transform their instruction, especially the formative assessment of students' vocabulary knowledge. This study's results contribute to our understanding of how teachers make technology adoption decisions with implications for school leaders seeking to have their teachers make fullest possible use of technology innovations, for learning technology researchers developing future innovations, and for researchers inquiring into technology-enabled formative assessments of reading comprehension.

## Table of Contents

Acknowledgments.....	i
Dedication.....	iii
Abstract.....	iv
Table of Contents.....	vi
List of Tables.....	ix
List of Figures.....	xi
Chapter 1.....	1
Introduction.....	1
The Problem Facing Schools When They Adopt Technology.....	1
The Impact of the Problem.....	2
Diffusion of Innovation Theory.....	4
Criticisms of Diffusion of Innovations (DOI) Research.....	8
The Innovation Adoption Profile (IAP).....	10
Investigating the Innovation Adoption Profile (IAP) model.....	17
The Innovation Used in This Study.....	18
The Research Questions.....	18
Chapter 2.....	20
Review of the Literature.....	20
The Literature on Annotation and Digital Annotation Systems.....	20
The historical role of annotation in learning from text.....	20
Digital annotation systems.....	23
Research into the development and uses of digital annota.....	24
Literacy researchers' approaches to annotation research.....	26
Comparisons and Contrasts Between Diffusion of Innovation (DOI) Theory and Learning Technology Implementation Studies.....	29
The Criticisms of Diffusion of Innovations Research.....	37
Chapter 3.....	43
Methods.....	43
Phase 1: Teachers' Micro-Adoptions.....	43
Research Design.....	43
Participants.....	44
Materials.....	45
Survey instruments.....	45
Workshop presentation.....	53
Digital annotation software.....	54
Online support materials.....	54
Online form for registering the adoption decision.....	55
Follow-up interviews.....	55
Incentives.....	55
Procedures.....	56
Workshops.....	56
Phase 2: Describing Post-Adoption Outcomes.....	59
Research Design.....	59

Phase 2 participants.....	59
Semi-structured telephone interview protocol.....	60
Participant-provided curricular materials. ....	61
Examples of student work.....	61
Procedures.....	61
Analysis.....	62
Question 1.....	62
Question 2.....	64
Question 3.....	66
Chapter 4.....	66
Results.....	66
Question 1.....	67
Response rates.....	67
Demographics.....	69
Innovativeness.....	71
Perceived Characteristics of Innovative Scale (PCIS).....	76
Dependent variable (field trial participation).....	79
Reliability of the scales.....	80
Logistic regression analysis.....	81
Summary of the analysis of the quantitative data.....	98
Follow-up interviews.....	98
Summary of the analysis of the interview data.....	109
Response to research question 1.....	110
Question 2.....	111
Summary of the RAT analysis of the cases.....	120
Response to research question 2.....	120
Question 3.....	121
The Perceived Characteristics of the Innovation.....	122
Perceived Characteristics of the Innovation in the data.....	123
Response to research question 3.....	ix
Chapter 5.....	137
Discussion.....	137
Overview of the Study and the Results.....	137
The Effect of Participant Perceptions on Micro-Adoption Decisions.....	139
Participants' Uses Of Repligo™ Digital Annotation Software.....	141
Revisions to the IAP Model, Instruments, and Protocols.....	146
Revisions to the IAP instruments and protocol.....	147
Methodological Contributions of the IAP to the Development of Cognitively-Oriented Technology Innovations and School Leadership.....	150
Contributions to the development of cognitively-oriented technology innovations.....	151
Contributions to school leadership.....	161
Hypothetical example of the use of the IAP by school leaders.....	165
Methodological Contributions to Diffusion of Innovations Research.....	168
Limitations of the Study.....	170

Limitations pertaining to sample size and data quality.....	170
Limitations specific to DOI research. ....	172
Future Directions .....	174
Conclusion .....	175
References.....	176
Appendices.....	184
Appendix A Innovativeness Scale .....	185
Appendix B Perceived Organizational Innovativeness Scale.....	188
Appendix C Perceived Characteristics of Innovating Scale .....	191
Appendix D Outline of RepliGo™ Workshops.....	195
Appendix E Screenshots of RepliGo™ Software .....	197
Appendix F Screenshots of RepliGo™ Online Support Materials .....	199
Appendix G Phase 1 Follow-up Interview Protocol and Voicemail Prompts .....	203
Appendix H Phase2 RAT Taxonomy Interview Protocol .....	205
Appendix I Perceived Characteristics of the Innovation Definitions and Sample Data .....	207
Appendix J Phase 2 RAT Taxonomy Self-Report.....	210
Appendix K Permissions to Reprint .....	212
Appendix L University of Minnesota Institutional Review Board Approval.....	216

## List of Tables

- Table 1. Reliability Coefficients of the Compeau and Meister (2003) Perceived Characteristics of Innovating Scale (PCIS) Subscales.
- Table 2. Response Rates for Each Survey in the Innovation Adoption Profile (IAP) Based on Number of Participant
- Table 3. Participant Demographics
- Table 4. Raw Score Descriptive Statistics for the Innovativeness Scale and Perceived Organizational Innovativeness Scale
- Table 5. Percentages of Participants in Each Adopter Category Based on Innovativeness Scale and Perceived Organizational Innovativeness Scale Raw Scores
- Table 6. Number of Items and Descriptive Statistics for the Perceived Characteristics of Innovating Scale
- Table 7. Reliability of Scales by Responder Group Compared to Reliability Reported in the Literature.
- Table 8. Correlations Between IAP Model Variables
- Table 9. Summary of the Five Logistic Regression Models
- Table 10. Predicted Probability of Field Trial Participation – Model 1
- Table 11. Predicted Probability of Field Trial Participation – Model 2
- Table 12. Predicted Probability of Field Trial Participation – Model 3
- Table 13. Predicted Probability of Field Trial Participation – Model 4
- Table 14. Predicted Probability of Field Trial Participation – Model 5
- Table 15. Codes, Definitions, and Number of Applications for the Perceived Characteristics of Innovation Coding of Participants' Follow-up Interview Data
- Table 16. Frequencies and Perception of Statements from Follow-up Interviews, Voicemails, and Emails Across Participants

- Table 17. Participant Interview Duration, Field Trial Response, and Unique Statements about the Perceived Characteristics of RepliGo™
- Table 18. Frequency of Coding Intersections for the Perceived Characteristics of the Innovation of RepliGo™ and ID numbers of Participants with Double-coded Data
- Table 19. Richard's Initial Perceptions of RepliGo™'s Characteristics as Reflected in His PCIS Subscale Means and Follow-up Interview
- Table 20. Julia's Initial Perceptions of RepliGo™'s Characteristics as Reflected in His PCIS Subscale Means and Follow-up Interview
- Table 21. Richard and Julia's Perceptions of RepliGo™'s Characteristics as Reflected in Their Field Trial Interviews

## List of Figures

- Figure 1. Rogers' model of the innovation-decision process.
- Figure 2. Stage 1 of the Innovation Adoption Profile (IAP) and the role its elements play in predicting teachers' micro-adoption decision.
- Figure 3. Stage 2 of the Innovation Adoption Profile (IAP) and the role its elements play in predicting post-adoption outcomes within the Replacement/Amplification/Transformation framework.
- Figure 4. A Model of Teachers' Technology-Learning Phases
- Figure 5. Comparison of Rogers (2003) model of the innovation-decision process with Hughes (2003) model of teachers' technology learning.
- Figure 6. Evolution of the Constructs Included in the Perceived Characteristics of Innovating Scale
- Figure 7. Sequence of events in Phase 1 of the study.
- Figure 8. Percentage Distribution of Participants' Individual Innovativeness and Perceived Organizational Innovativeness Across Adopter Categories Compared With Expected Theoretical Distribution
- Figure 9. Equation for a 15-factor logistic regression analysis
- Figure 10. Revised Innovation Adoption Profile (IAP) model.